ENERGY MANAGEMENT STANDARDS

NEW LOW & HIGH RISE

APARTMENT BUILDINGS

Ministry of Housing

Technical Support Services Branch

Ontario Ministry of Housing

Technical Support Services Branch

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NEW LOW & HIGH RISE APARTMENT BUILDINGS

May 1989

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and its Agencies

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ONTARIO MINISTRY OF HOUSING

WITH

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STAFF OF THE MINISTRY OF HOUSING

UNDER THE SUPERVISION OF

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ONTARIO MINISTRY OF HOUSING

TABLE OF CONTENTS

1.0	EXECUTIVE SUMMARY	1
2.0	INTRODUCTION	11
3.0	METHODOLOGY	12
4.0	LOADSHAPER ANALYSIS	13
	4.1 PROGRAM DESCRIPTION	13
	4.2 BUILDING AND SYSTEMS DESCRIPTIONS	13
5.0	LIFE CYCLE COSTING ANALYSIS	14
	5.1 LIFE CYCLE COSTING MODEL DESCRIPTION	14
	5.2 PRESENT WORTH ANALYSIS	14
	5.3 ECONOMIC ANALYSIS	15

APPENDIX A LOADSHAPER INPUTS

APPENDIX B LOADSHAPER REPORTS

APPENDIX C LIFE CYCLE COSTING INPUTS

APPENDIX D RESULTS OF LIFE CYCLE COSTING ANALYSIS

APPENDIX E LIFE CYCLE COSTING SPREADSHEET DOCUMENTATION

1.0 EXECUTIVE SUMMARY

The Ontario Ministry of Housing awarded Engineering Interface Limited a contract to conduct a life cycle costing study for the installation and operation of four types of heating systems in low and high rise apartment buildings. The study examined four combinations of heating systems, for two types of buildings (Seniors/Singles, Family), for three building sizes (2 or 4, 10, 22 storeys) and for two locations in the province (North York, Thunder Bay). Based on minimizing the present worth owning and operating costs of each scenario, recommendations were made regarding the operating heating budgets (life cycle costs) and total energy targets (BEPI's) for new non profit apartment buildings.

In the Seniors/Singles category, in North York, the optimal combination of heating systems were electric space heating, gas corridor fresh air and gas domestic hot water (Hybrid System #1 in the study). The optimal operating heating budgets and corresponding total energy targets are tabulated in Table 1.

In the Family category, in North York, the optimal combination of heating systems were electric space heating, gas corridor fresh air and gas domestic hot water (Hybrid System #1 in the study). The optimal operating heating budgets and corresponding total energy targets are tabulated in Table 1.

In the Seniors/Singles category, in Thunder Bay, the optimal combination of heating systems were gas space heating, gas corridor fresh air and gas domestic hot water (All Gas System in the study). The exception was in the low rise building type where the optimal combination of heating systems were electric space heating, gas corridor fresh air and domestic hot water (Hybrid System #1 in this study). The optimal operating heating budgets and corresponding total energy targets are tabulated in Table 2.

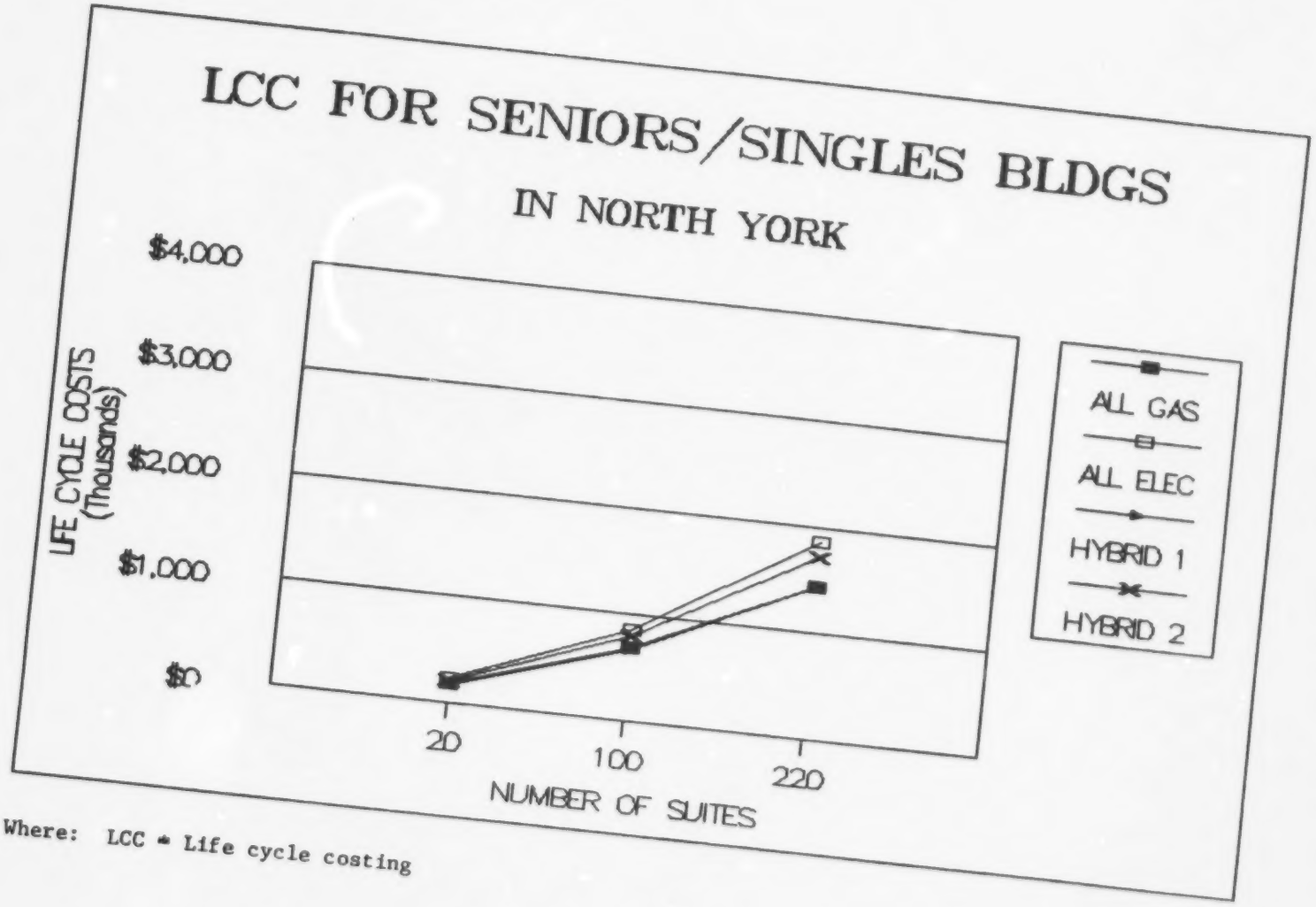
In the Family category, in Thunder Bay, the optimal combination of heating systems were electric space heating, gas corridor fresh air and gas domestic hot water (Hybrid System #1 in the study). The optimal operating heating budgets and corresponding total energy targets are tabulated in Table 2.

Buildings of intermediate size may have their operating heating budgets determined from the graphs provided in Figures 1,2,3 and 4. Additional studies were completed for deregulated gas rates (see Figures 5, 6, 7 and 8). Complete details on all the scenarios investigated are provided in sub-section 5.3.

Table 1 - Summary for North York		Optimal Operating Heating Budget (Life Cycle Cost) ($/sqft)	Corresponding Total Energy Target (BEPI) (ekwh/sqft/yr)
Seniors/Singles	Low Rise	$15.92	23.1
	Med Rise	$12.48	23.5
	High Rise	$12.21	23.8
Family	Low Rise	$10.01	18.6
	Med Rise	$ 7.90	17.9
	High Rise	$ 7.56	18.1

Table 2 - Summary for Thunder Bay		Optimal Operating Heating Budget (Life Cycle Cost) ($/sqft)	Corresponding Total Energy Target (BEPI) (ekwh/sqft/yr)
Seniors/Singles	Low Rise	$20.15	27.7
	Med Rise	$16.27	35.4
	High Rise	$15.61	36.4
Family	Low Rise	$12.93	21.6
	Med Rise	$10.55	20.7
	High Rise	$10.22	21.0

Note : Low, medium and high refers to 2, 10 and 22 storeys in Seniors/-Singles and 4, 10 and 22 storeys in Family buildings.



Where: LCC = Life cycle costing

Figure 1

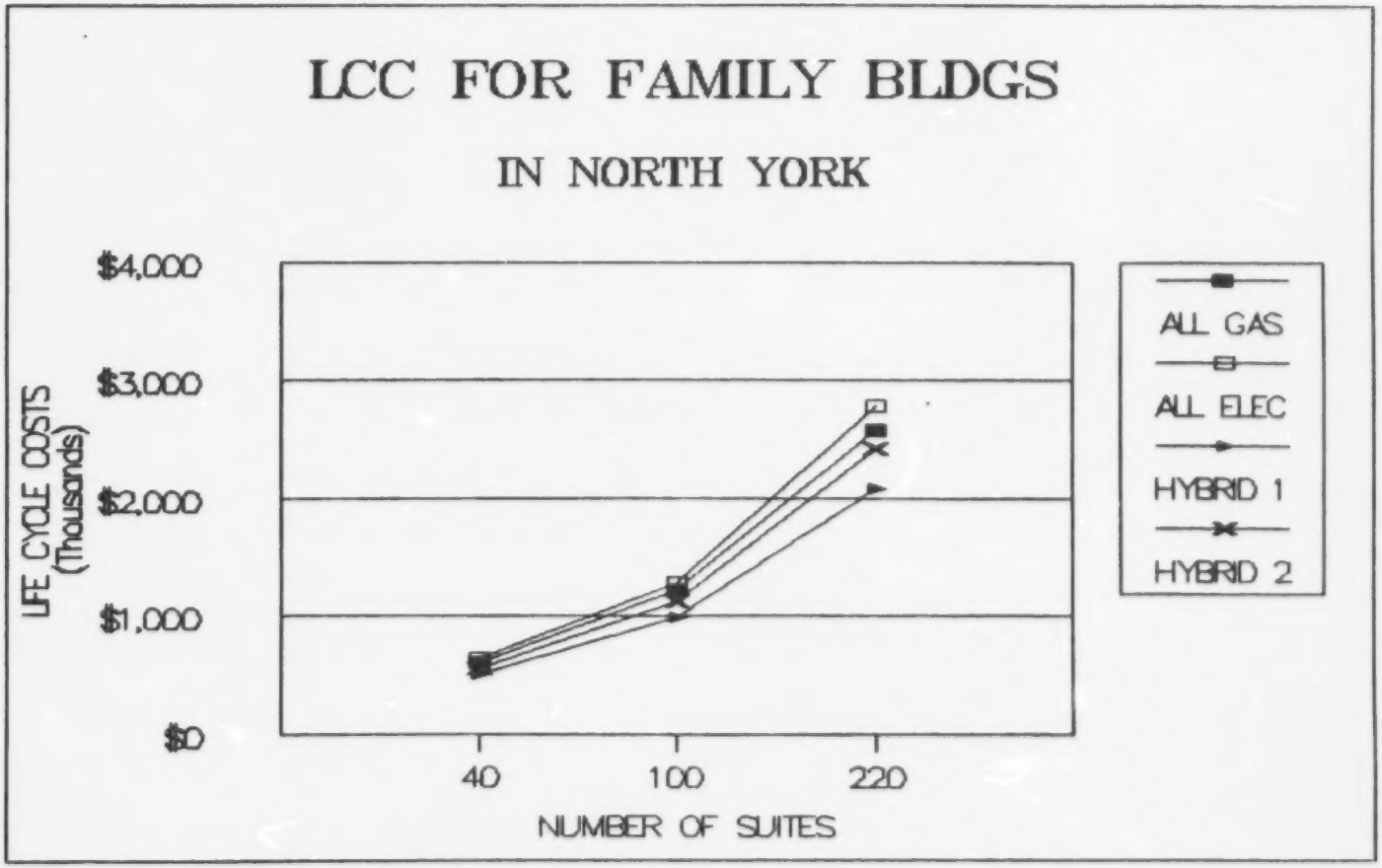

LCC FOR FAMILY BLDGS
IN NORTH YORK
$4,000
$3,000
$2,000
$1,000
$0
LIFE CYCLE COSTS (Thousands)
40
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 2

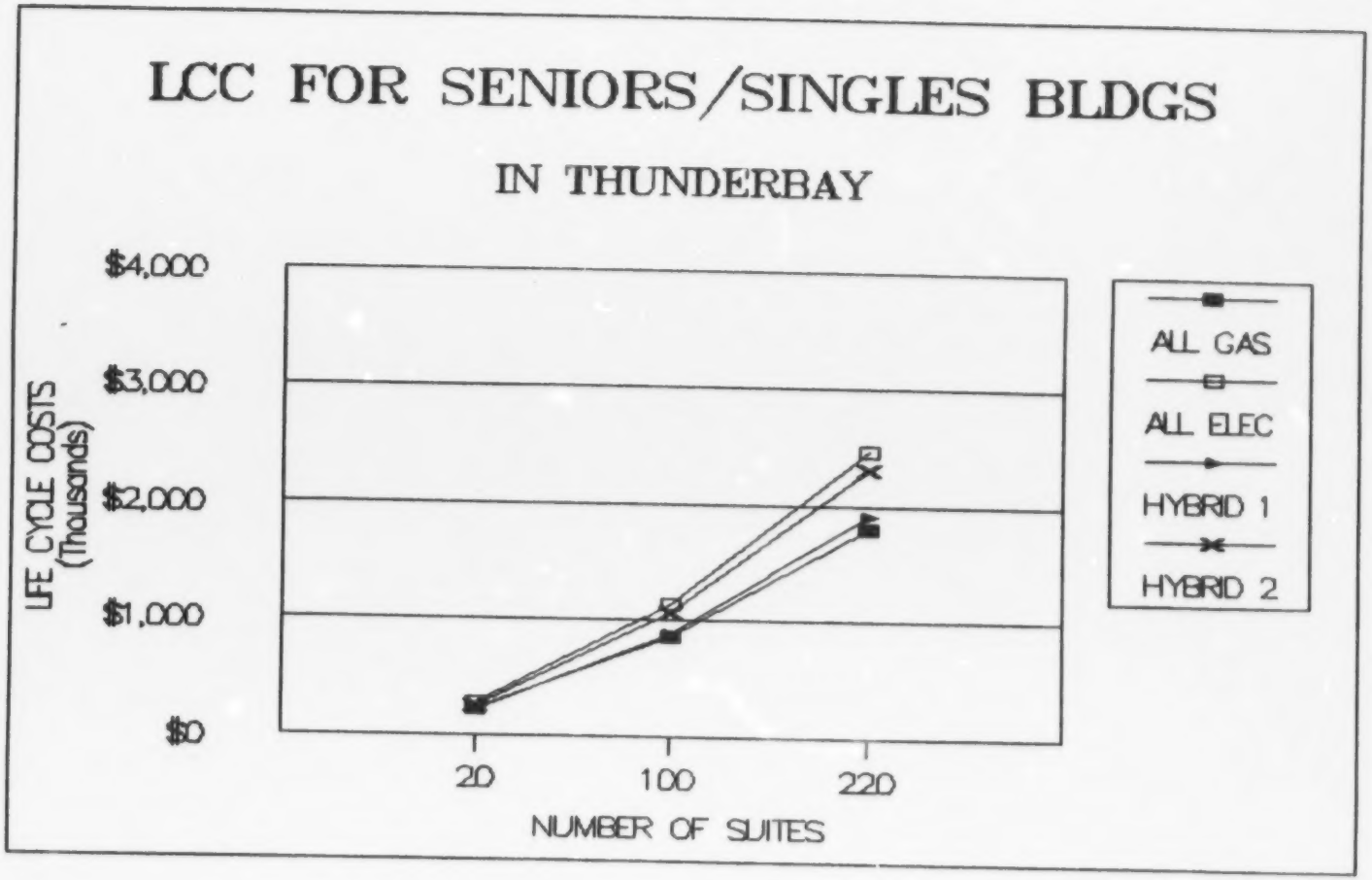

LCC FOR SENIORS/SINGLES BLDGS
IN THUNDERBAY
$4,000
$3,000
$2,000
$1,000
$0
LIFE CYCLE COSTS (Thousands)
20
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 3

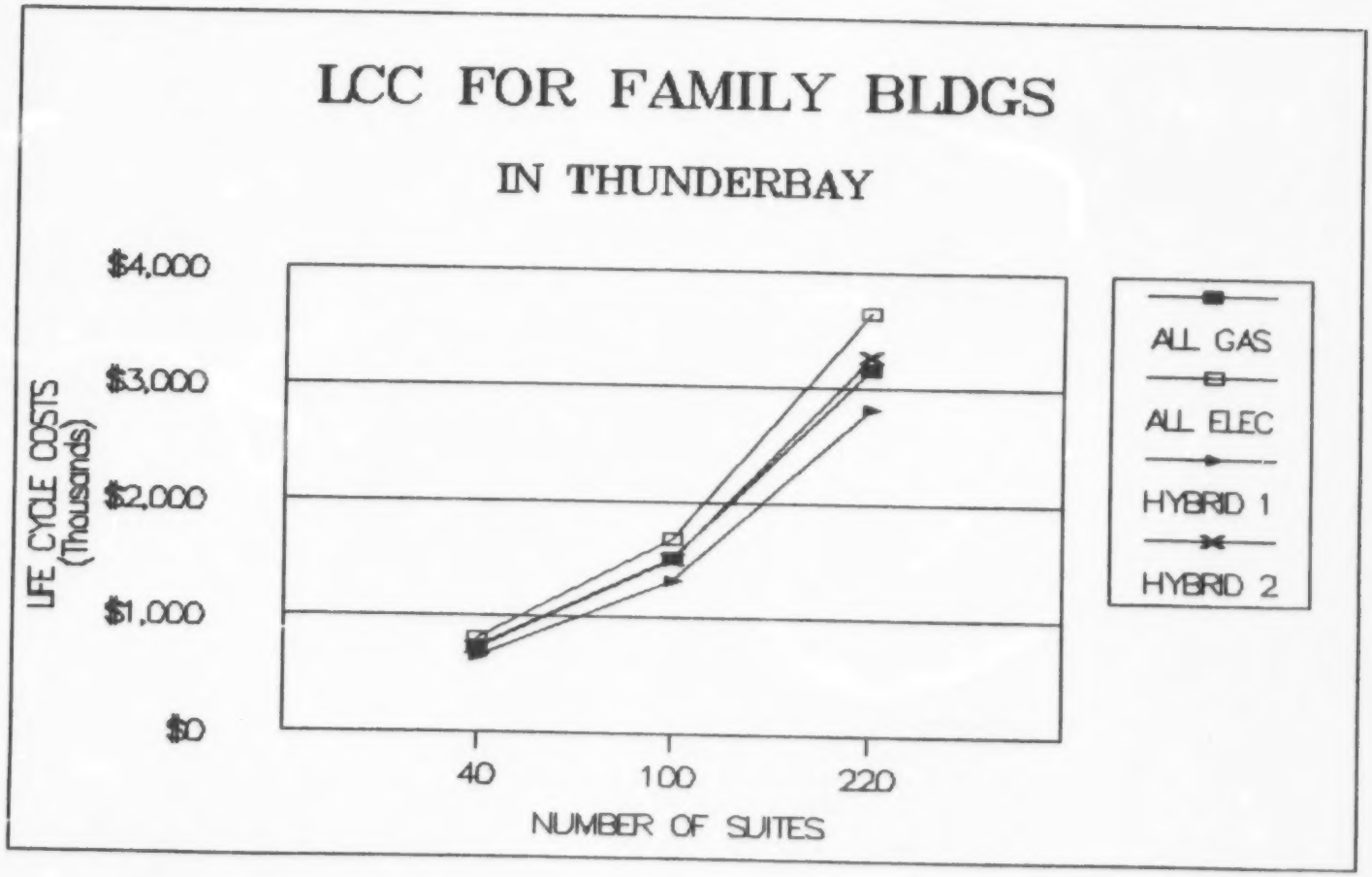

LCC FOR FAMILY BLDGS
IN THUNDERBAY
$4,000
$3,000
$2,000
$1,000
$0
LIFE CYCLE COSTS (Thousands)
40
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 4

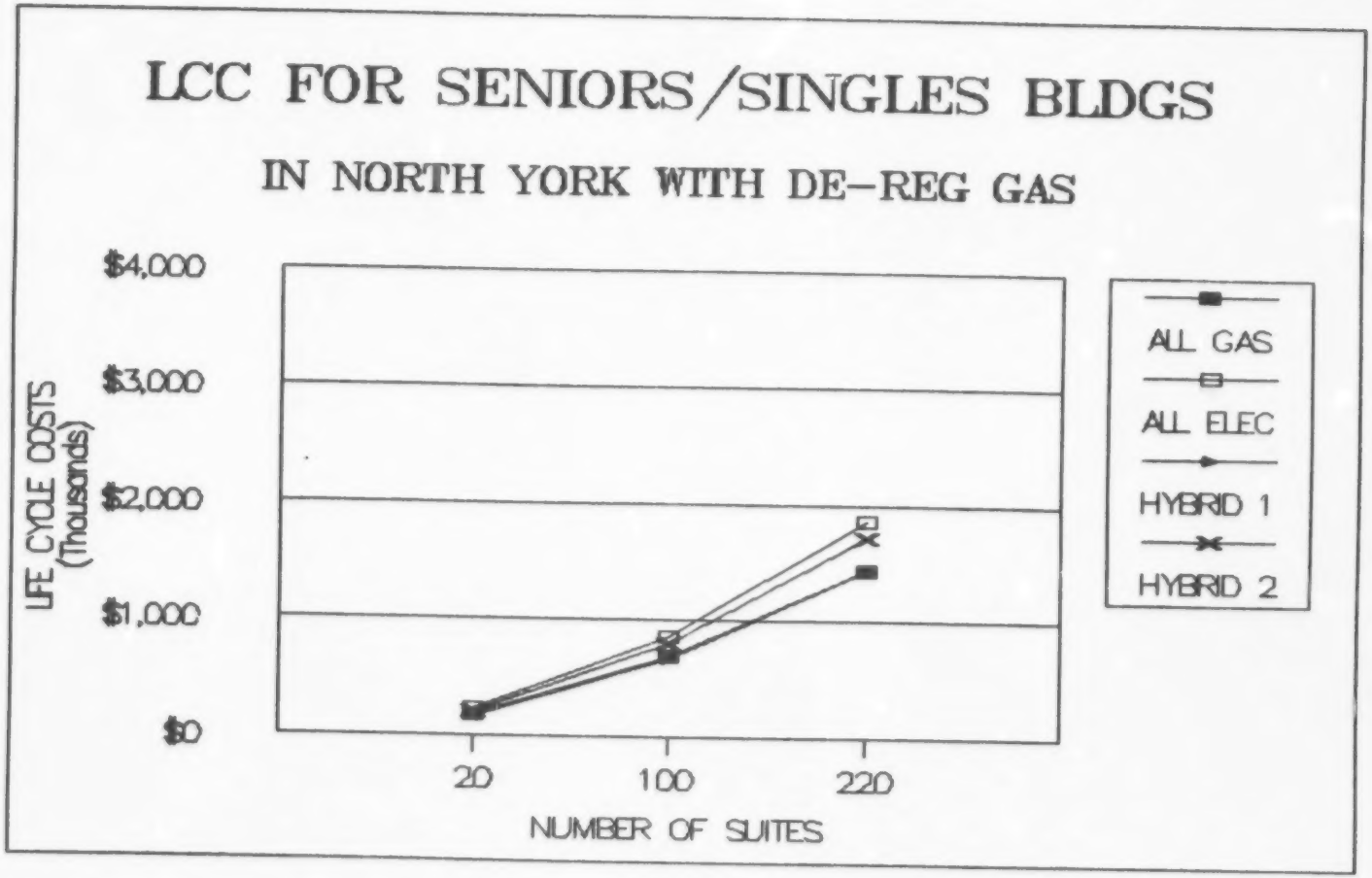

LCC FOR SENIORS/SINGLES BLDGS
IN NORTH YORK WITH DE-REG GAS
LIFE CYCLE COSTS (Thousands)
$4,000
$3,000
$2,000
$1,000
$0
20
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 5

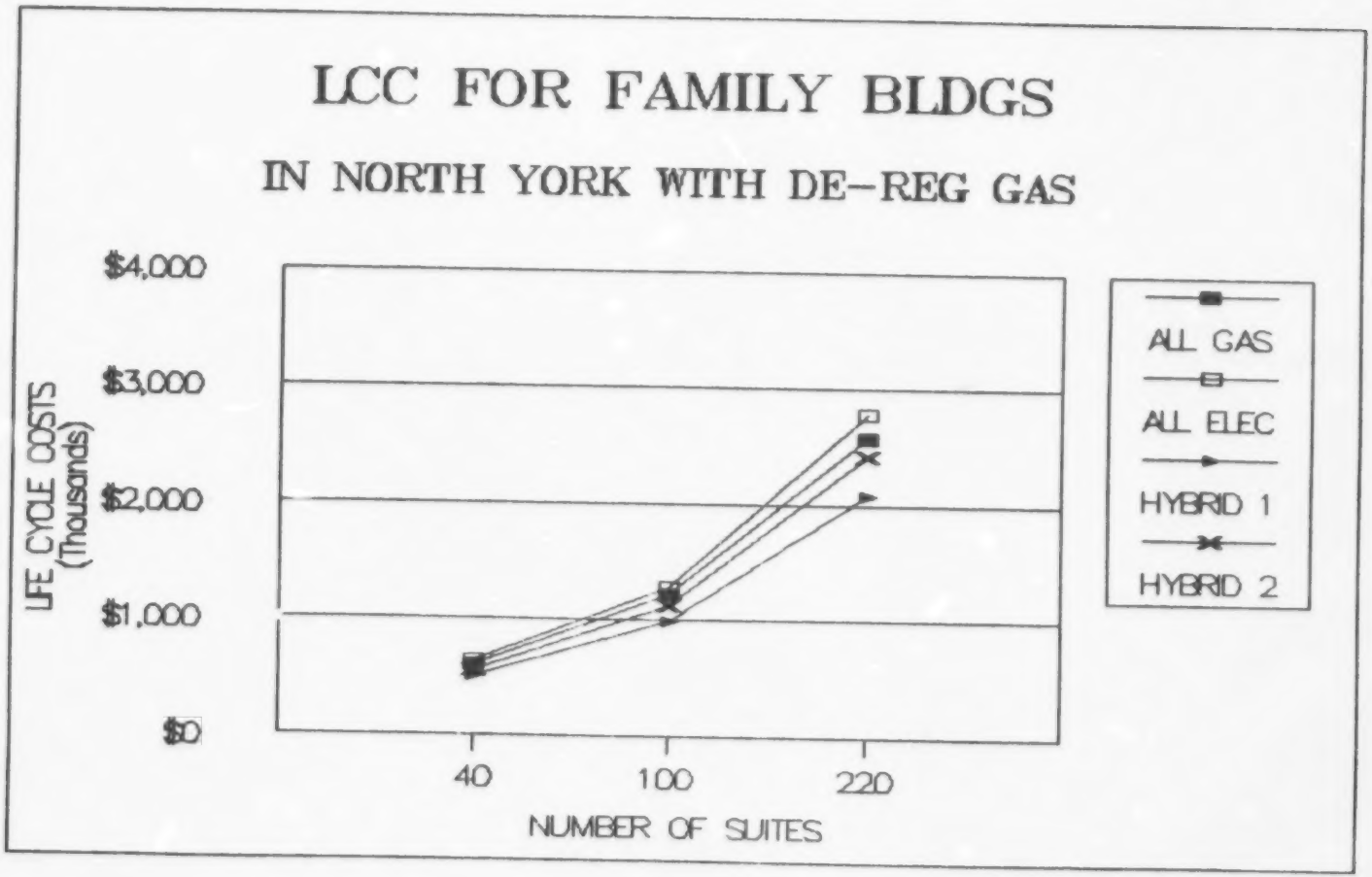

LCC FOR FAMILY BLDGS
IN NORTH YORK WITH DE-REG GAS
$4,000
$3,000
$2,000
$1,000
$0
LIFE CYCLE COSTS (Thousands)
40
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 6

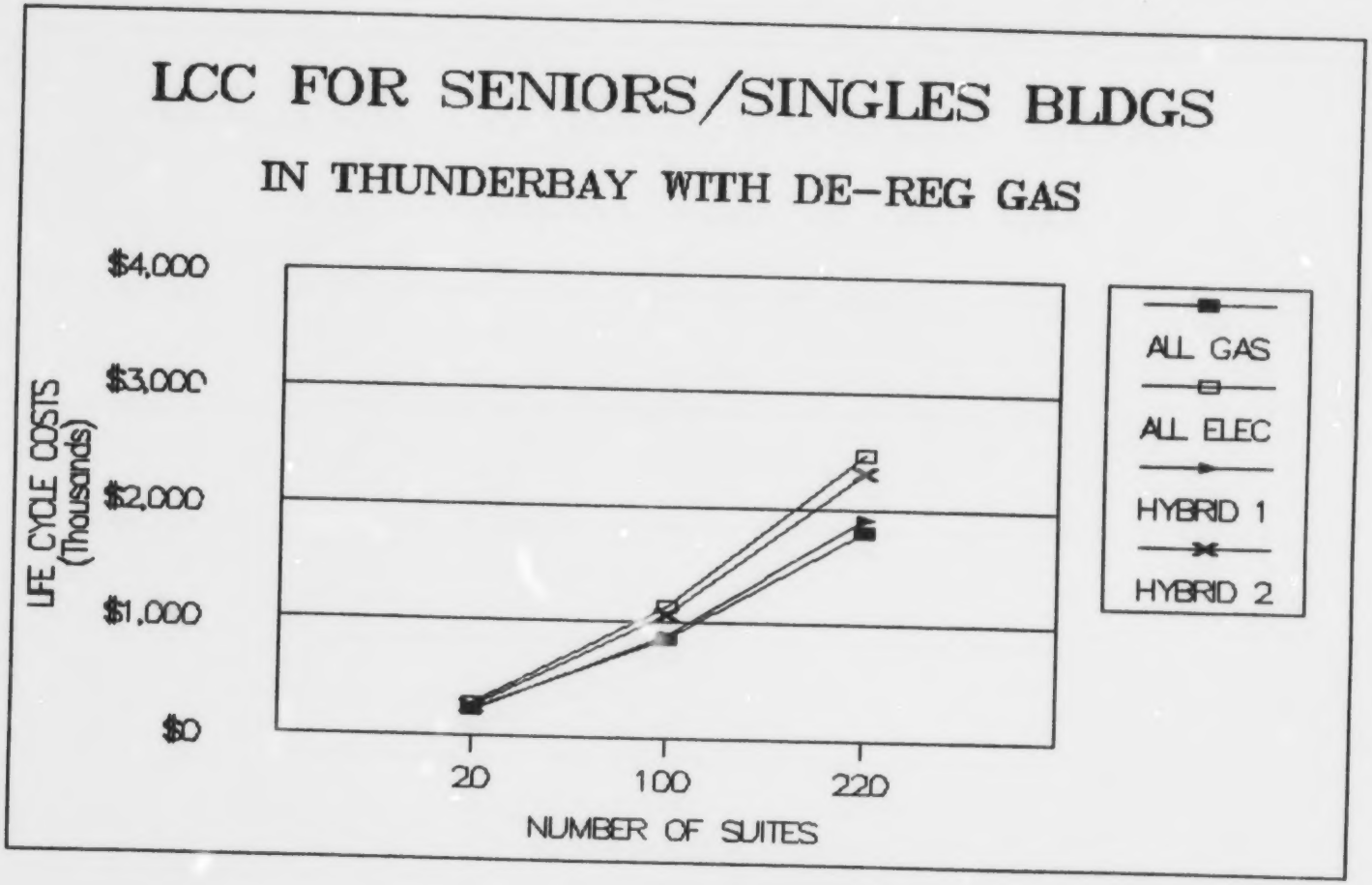

LCC FOR SENIORS/SINGLES BLDGS
IN THUNDERBAY WITH DE-REG GAS
$4,000
$3,000
$2,000
$1,000
$0
LIFE CYCLE COSTS (Thousands)
20
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 7

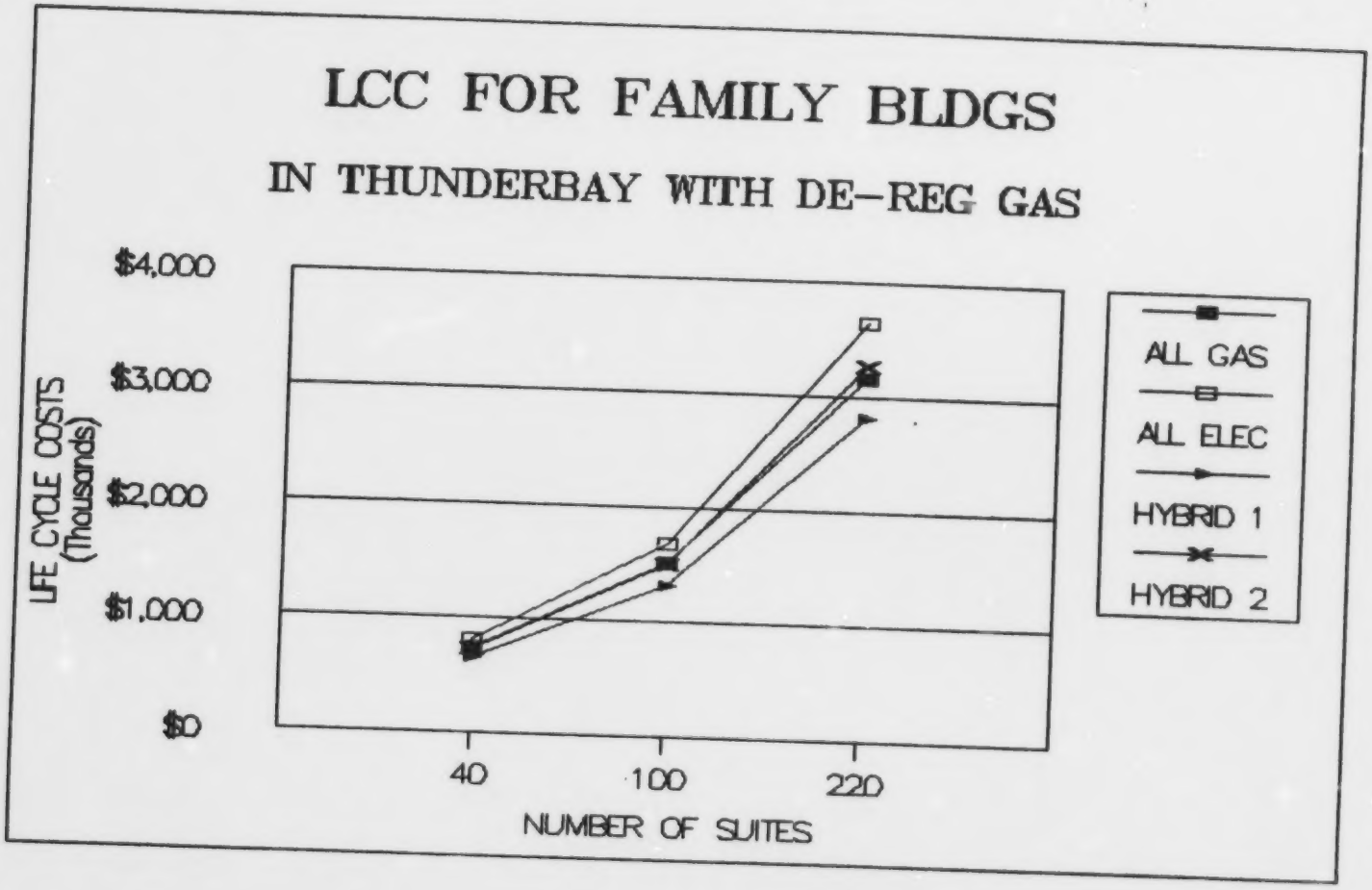

LCC FOR FAMILY BLDGS
IN THUNDERBAY WITH DE-REG GAS
$4,000
$3,000
$2,000
$1,000
$0
LIFE CYCLE COSTS (Thousands)
40
100
220
NUMBER OF SUITES
ALL GAS
ALL ELEC
HYBRID 1
HYBRID 2

Figure 8

2.0 INTRODUCTION

Engineering Interface Limited (EIL) was awarded a contract to provide the Ontario Ministry of Housing with a report detailing a life cycle costing analysis comparing the installation and operation of four types of heating systems in low and high rise apartment buildings. The results were to be summarized in tabular and graphical form showing Life Cycle Costs versus Number of Suites for the four Heating systems considered. The analysis was to be repeated for;

- Seniors/Singles housing
- Family housing
- Without deregulated gas
- With deregulated gas

The study was to meet the following scope of work:

1) Provide definitions of building usage, size, location and of heating system types.

2) Provide definitions of energy forms and heating systems end-use components through a life cycle costing analysis. The life cycle costing analysis was to take into account the following:

   - Initial capital investment.
   - Planned preventive maintenance and repair costs.
   - Equipment replacement cost over the expected 60 year life of a building.
   - Energy costs, including present and future rates.
   - Interest rates on investment and escalation.
   - Inflation rate.

3) Provide Building Energy Performance Indices (BEPI's) to reflect total energy use per square foot per year.

4) Provide the Loadshaper (building energy usage simulation program) software system complete with customization, installation, training and support.

5) Provide Loadshaper first run and reports serving objectives 1, 2 and 3 based on information provided by the Ministry of Housing.

3.0 METHODOLOGY

The methodology adopted was aimed at providing a flexible and reliable process which would ease data updating. This was achieved through the use of two computerized modelling techniques. The first was in the use of a building energy usage simulation program (Loadshaper) to optimize the selection of heating system components for different building configurations. The second was in the use of a life cycle costing model (set up on Lotus 1-2-3 spreadsheet) to determine the most cost effective heating system combination. The two model approach could then be used to develop any number of scenarios based on a selection of heating systems, building sizes, building locations, energy types, costs and escalation rates. This could be expanded in the future to analyze various HVAC systems. The individual steps taken are outlined below:

- Define standard buildings
- Define heating system configurations
- Complete building energy usage simulation models
- Define life cycle costing model
- Determine heating system costs
- Complete life cycle costing analyses
- Complete graphs to facilitate interpolation

The building energy usage simulation program used was Loadshaper Version 1.1 from Morgan Systems Corporation, in Berkeley, California. Refer to section 4.0 for details. The life cycle costing model was developed by EIL and based on generally accepted present worth techniques. This model plus modifications specified by the Ministry of Housing are detailed in section 5.0.

4.0 LOADSHAPER ANALYSIS

4.1 PROGRAM DESCRIPTION

The Loadshaper building energy usage simulation program was used to quickly analyze the performance of a building's mechanical and electrical systems in terms of annual energy use and costs. The process inherently required the user to provide details regarding the building's location, orientation, envelope, thermal loads, HVAC systems, plant and operation. This guaranteed a rigorous and consistent building definition from which a reliable economic analysis could be conducted. Loadshaper provided summary reports of building design and energy performance. The buildings' annual energy use and costs for electricity and gas were passed on to the life cycle model.

4.2 BUILDING AND SYSTEMS DESCRIPTIONS

The Ministry of Housing provided the following building types:

- Seniors/Singles buildings in 2,10 and 22 storeys with 20,100 and 220 suites respectively. Each floor having 10 suites.

- Family buildings in 4,10 and 22 storeys with 40,100 and 220 suites respectively. Each floor having 10 suites.

The Ministry of Housing provided the following heating system types:

Building Htg System	Space Htg	Corridor F/A	DHW Htg
all gas	gas fired hydronic	indirect gas fired	gas fired
all electric	electric baseboard	electric	electric
hybrid #1	electric baseboard	indirect gas fired	gas fired
hybrid #2	electric baseboard	electric	gas fired

Loadshaper inputs are shown in Appendix A.

Loadshaper results are shown in Appendix B.

5.0 LIFE CYCLE COSTING ANALYSIS

5.1 LIFE CYCLE COSTING MODEL DESCRIPTION

The life cycle model (spreadsheet) provides a tool for evaluating the cost of owning and operating the heating systems identified in this study. The user provides the following information:

- Building type, location, heating degree days and expected life.
- Economic discount rate for money and deregulated gas discount rate.
- Escalation rates for material, labour, electricity and gas.
- Heating equipment rated life.
- Installation, replacement and maintenance costs.
- Annual energy use and costs for electricity and gas.

The spreadsheet provides the user with tables for the three different sizes of building type chosen. Various tables summarize building areas, installation costs, replacement costs, maintenance costs, energy costs and life cycle costs. The life cycle costs are also shown graphically for interpolation between the specific building sizes used in the study. Complete documentation regarding the use of the spreadsheet is provided in Appendix E (note: familiarity with Lotus 1-2-3 is assumed).

5.2 PRESENT WORTH ANALYSIS

The life cycle costing (LCC) analysis used in this study was based on the present worth approach, ie. the owning and operating costs of each system were evaluated in terms of today's dollar value. Complete formulations are given in Figure 9.

In the present worth method, costs are presented as a single lump sum at the time of purchase. Future expenses are converted to equivalent dollar amounts at the time of acquisition. This conversion process is called discounting. The present worth of the entire life cycle cost is found by adding the initial investment to the discounted future expenses. In converting future values to present values, "discounting" is performed by applying interest (discount) formulae to the estimated costs or benefits of the given project. The main idea behind discounting is that it should reflect the fact that today's money is worth more than tomorrow's, i.e., it can earn interest

Furthermore, if money is borrowed to finance a project, the loan repayment rate is not necessarily used in life cycle cost analysis since the borrowing rate doesn't usually represent the true worth of these funds. Consideration of loan repayment rate (or interest on borrowed money) is usually a later consideration when competitive financing is being reviewed.

Present worth may be better understood using the following discussion. The present value of a future dollar is the value of that dollar today taking into consideration the rate at which it's value varies over time, ie. if money is inflating (or negatively escalating) at 10% then $1.00 today will be worth $0.90 a year from now. Similarly, considering the escalation of electricity at 6%, the $1.06 you expect to spend one year from now to operate a 100 watt light bulb is only costing you $1.00 today. A present worth analysis takes inflation and escalation effects into account.

In our study, equipment, labour, electricity and gas costs are allowed to escalate independently. Their effect is countered by the investor's cost of capital for investment purposes. In this way only the net effect of future costs and benefits are taken into account and the investor may equally compare the results of this study with any of his other investment opportunities.

5.3 ECONOMIC ANALYSIS

Energy cost data was obtained from Loadshaper using utility rates for North York and Thunder Bay. Equipment and labour costs for installation, replacement and maintenance as well as equipment rated life were obtained from (refer to Appendix C):

- Selection of Appropriate Mechanical Systems for Apartment Buildings; The ECE Group, May 1981.
- Heating Breakdown; Hanscomb Consultants Inc.; September 1988.
- In-house.

The results of the life cycle costing analysis are detailed in Appendix D. There are four complete sets of data comprised of 5 pages each. These are as follows:

- LCC Analysis for Seniors/Singles Buildings in North York.
- LCC Analysis for Seniors/Singles Buildings in Thunder Bay.
- LCC Analysis for Family Buildings in North York.
- LCC Analysis for Family Buildings in Thunder Bay.

FIGURE 9 MOH - LCC METHODOLOGY

EQ =	EQUIPMENT INSTALLATION COST	EQM =	EQUIPMENT MAINTENANCE COS'
LB =	LABOUR INSTALLATION COST	LBM =	LABOUR MAINTENANCE COST
CM =	COMMISSIONING COST	EE =	ELECTRIC ENERGY COST
EQR =	EQUIPMENT REPLACEMENT COST	GE =	GAS ENERGY COST
LBR =	LABOUR REPLACEMENT COST	CFE =	CITY FACTOR EQPT
N =	BUILDING LIFE CYCLE	CFL =	CITY FACTOR LABOUR

I = DISCOUNT RATE (BUYER'S COST OF CAPITAL)
M = EQUIPMENT ESCALATION RATE
L = LABOUR ESCALATION RATE
E = ELECTRICITY ESCALATION RATE
G = GAS ESCALATION RATE

PWFM = PRESENT WORTH FACTOR EQUIPMENT
PWFL = PRESENT WORTH FACTOR LABOUR
PWFE = PRESENT WORTH FACTOR ELECTRICITY
PWFG = PRESENT WORTH FACTOR GAS

LIFE CYCLE COST

DEF'N THE COST OF INSTALLING, MAINTAINING AND REPLACING THE BUILDING'S MECHANICAL SYSTEMS OVER THE LIFE CYCLE OF THE BUILDING. THE LIFE CYCLE COST IS EXPRESSED IN TERMS OF TODAY'S DOLLAR VALUE USING EQUIPMENT, LABOUR AND ENERGY ESCALATION RATES, AS WELL AS, THE DEPRECIATING VALUE OF MONEY.

```
LCC =  CFE x
       ( EQ                  EQUIPMENT INSTALLATION COST
       + (EQM x PWFM)        PRESENT WORTH EQUIPMENT MAINTENANCE COST
       + (EQR x PWFEQ) )     PRESENT WORTH EQUIPMENT REPLACEMENT COST
     + CFL x
       ( LB                  LABOUR INSTALLATION COST
       + CM                  COMMISSIONING COST
       + (LBM x PWFL)        PRESENT WORTH LABOUR MAINTENANCE COST
       + (LBR x PWFLB) )     PRESENT WORTH LABOUR REPLACEMENT COST
     + (EE x PWFE)           PRESENT WORTH ELECTRICITY COST
     + (GE x PWFG)           PRESENT WORTH GAS COST
```

PRESENT WORTH FACTOR FORMULA (TYPICAL)

$$PWFM,L,E,G = \frac{A \times (A^{N} - 1)}{(A - 1)}$$

$$A = \frac{(1 + M,L,E,G)}{(1 + I)}$$

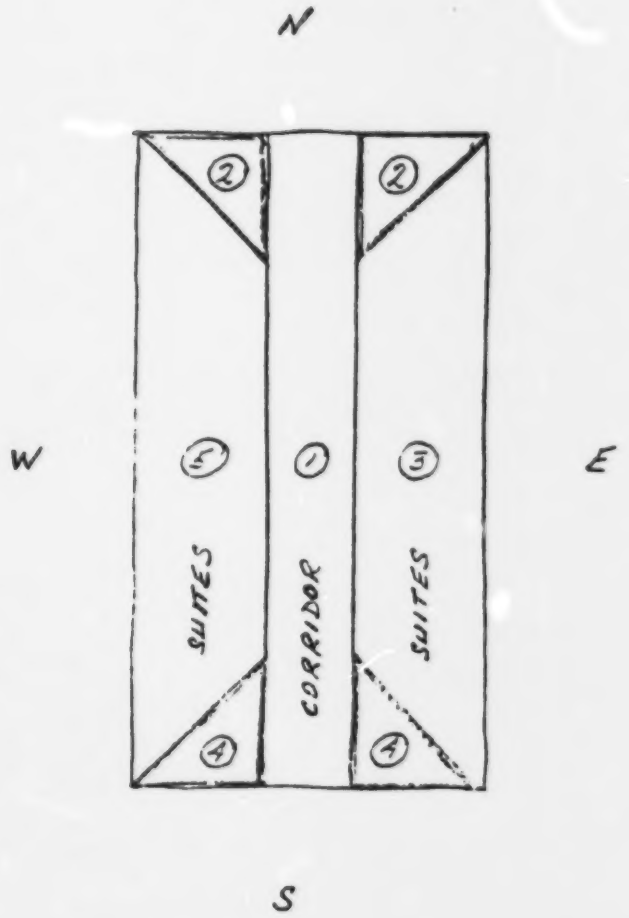
M,L,E,G =EQUIPMENT, LABOUR, ELECETRICITY AND GAS ESCALATION RATES
I =DISCOUNT RATE
N =BUILDING LIFE CYCLE

NOTE : EQR AND LBR ARE COMPUTED FOR WHOLE REPLACEMENTS ONLY.

APPENDIX A LOADSHAPER INPUTS

PROVIDED BY THE MINISTRY OF HOUSING

GENERIC AP'T. BLDG.



ZONE #	NAME	SYSTEM
1	CORRIDOR	1
2	NORTH (SUITES)	2
3	EAST (SUITES)	2
4	SOUTH (SUITES)	2
5	WEST (SUITES)	2

DESIGN CONDITIONS (THEORETICAL)

		SYSTEM 1			SYSTEM 2	
ITEM	SYSTEM 1 (CORRIDOR)	WINTER (SEPT.-MAY)	SUMMER (JUNE-AUG.)	SYSTEM 2 (SUITES)	WINTER (SEPT.-MAY)	SUMMER (JUNE-AUG.
HEATING	FRESH AIR (100 % O.A.)	60°F (HEATED TO)	—	HYDRONIC HTG.	74°F (HEATED TO)	—
COOLING	100 % O.A. (NO A/C)	—	—	WINDOW A/C UNITS @ 10 SUITES TOTAL = 15 TONS	—	76°F (COOLED TO
EXHAUST	10,000 CFM TRANSFERRED TO SYSTEM 2	ON FOR 8 HRS/DAY	ON FOR 24 HRS/DAY	20,000 CFM COMPRISED OF 50 % O.A (10,000 CFM) & 50 % FROM SYSTEM 1 (10,000 CFM)	ON FOR 8 HRS/DAY	ON FOR 24 HRS/DAY
SUPPLY	10,000 CFM O.A. (100 % O.A.)	ON FOR 8 HRS/DAY	ON FOR 24 HRS/DAY	10,000 CFM INFILTRATION AIR	ON FOR 8 HRS/DAY	ON FOR 24 HRS/DAY

APPENDIX B LOADSHAPER REPORTS

PROVIDED BY THE MINISTRY OF HOUSING

APPENDIX C LIFE CYCLE COSTING INPUTS

LIFE CYCLE COSTING INPUTS

1. Building Location Cost Escalations
2. Installation Costs
3. Equipment Rated Life
4. Equipment Replacement Costs
5. Annual Maintenance Costs

1. BUILDING LOCATION COST ESCALATIONS

BUILDING LOCATION COST ESCALATION FACTORS

ID	CITY	EQPT INDEX	LABOUR INDEX
1	NORTH YORK	100%	100%
2	OTTAWA	103%	115%
3	KINGSTON	103%	115%
4	SUDBURY	105%	119%
5	THUNDERBAY	105%	118%
6	HAMILTON	100%	112%
7	LONDON	100%	104%
8	WINDSOR	100%	108%
9	TORONTO	100%	100%

2. INSTALLATION COSTS

SYSTEM - ALL GAS	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	GAS BOILER PLANT	575	440	415
	GAS SERVICE PIPING	175	140	135
	WALLFIN RADIATION	900	700	660
	PIPING/PUMPS/EXP TANK	870	690	670
	INSULATION	135	105	105
CORRIDOR FRESH AIR	ROOF TOP UNIT	260	205	190
	GAS SERVICE PIPING	40	30	25
DOMESTIC HOT WATER	BOILERS/STORAGE	170	145	135
	GAS SERVICE PIPING	35	30	25
TOTAL MATRL & LABOUR		3160	2485	2360

SYSTEM - ALL GAS	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	GAS BOILER PLANT	374	286	270
	GAS SERVICE PIPING	61	49	47
	WALLFIN RADIATION	450	350	330
	PIPING/PUMPS/EXP TANK	348	276	268
	INSULATION	88	68	68
CORRIDOR FRESH AIR	ROOF TOP UNIT	208	164	152
	GAS SERVICE PIPING	14	11	9
DOMESTIC HOT WATER	BOILERS/STORAGE	111	94	88
	GAS SERVICE PIPING	12	11	9
TOTAL MATERIAL		1666	1309	1241

SYSTEM - ALL GAS	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	GAS BOILER PLANT	201	154	145
	GAS SERVICE PIPING	114	91	88
	WALLFIN RADIATION	450	350	330
	PIPING/PUMPS/EXP TANK	522	414	402
	INSULATION	47	37	37
CORRIDOR FRESH AIR	ROOF TOP UNIT	52	41	38
	GAS SERVICE PIPING	26	20	16
DOMESTIC HOT WATER	BOILERS/STORAGE	59	51	47
	GAS SERVICE PIPING	23	20	16
TOTAL LABOUR		1495	1177	1120

SYSTEM - ALL GAS	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	EQUIPMENT	1321	1029	983
	LABOUR	1334	1046	1002
CORRIDOR FRESH AIR	EQUIPMENT	222	175	161
	LABOUR	78	61	54
DOMESTIC HOT WATER	EQUIPMENT	123	105	97
	LABOUR	82	70	64
TOTAL EQUIPMENT/UNIT		1666	1309	1241
TOTAL LABOUR/UNIT		1495	1177	1120
TOTAL EQUIPMENT		33310	130850	272910
TOTAL LABOUR		29890	117650	246290
TOTAL PROJECT		63200	248500	519200

SYSTEM - ALL ELECT	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	450	310	300
	POWER WIRING	525	380	360
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	215	145	140
	POWER WIRING	250	190	175
DOMESTIC HOT WATER	ELECT HEATER/STORAGE	210	150	145
	POWER WIRING	280	195	190
TOTAL MATRL & LABOUR		1930	1370	1310

SYSTEM - ALL ELECT	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	270	186	180
	POWER WIRING	263	190	180
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	172	116	112
	POWER WIRING	125	95	88
DOMESTIC HOT WATER	ELECT HEATER/STORAGE	137	98	94
	POWER WIRING	140	98	95
TOTAL MATERIAL		1106	782	749

SYSTEM - ALL ELECT	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	180	124	120
	POWER WIRING	263	190	180
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	43	29	28
	POWER WIRING	125	95	88
DOMESTIC HOT WATER	ELECT HEATER/STORAGE	74	53	51
	POWER WIRING	140	98	95
TOTAL LABOUR		824	588	561

SYSTEM - ALL ELECT	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	EQUIPMENT	533	376	360
	LABOUR	443	314	300
CORRIDOR FRESH AIR	EQUIPMENT	297	211	200
	LABOUR	168	124	116
DOMESTIC HOT WATER	EQUIPMENT	277	195	189
	LABOUR	214	150	146
TOTAL EQUIPMENT		1106	782	749
TOTAL LABOUR		824	588	561
TOTAL EQUIPMENT		22120	78200	164725
TOTAL LABOUR		16480	58800	123475
TOTAL PROJECT		38600	137000	288200

SYSTEM - HYBRID #1	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	450	310	300
	POWER WIRING	525	380	360
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	ROOF TOP UNIT	260	205	190
	GAS SERVICE PIPING	135	110	105
DOMESTIC HOT WATER	BOILERS/STORAGE	170	145	135
	GAS SERVICE PIPING	35	30	25
TOTAL MATRL & LABOUR		1575	1180	1115

SYSTEM - HYBRID #1	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	270	186	180
	POWER WIRING	263	190	180
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	ROOF TOP UNIT	208	164	152
	GAS SERVICE PIPING	47	39	37
DOMESTIC HOT WATER	BOILERS/STORAGE	111	94	88
	GAS SERVICE PIPING	12	11	9
TOTAL MATERIAL		911	683	645

SYSTEM - HYBRID #1	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	180	124	120
	POWER WIRING	263	190	180
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	ROOF TOP UNIT	52	41	38
	GAS SERVICE PIPING	88	72	68
DOMESTIC HOT WATER	BOILERS/STORAGE	59	51	47
	GAS SERVICE PIPING	23	20	16
TOTAL LABOUR		665	497	470

SYSTEM - HYBRID #1	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	EQUIPMENT	533	376	360
	LABOUR	443	314	300
CORRIDOR FRESH AIR	EQUIPMENT	255	203	189
	LABOUR	140	113	106
DOMESTIC HOT WATER	EQUIPMENT	123	105	97
	LABOUR	82	70	64
TOTAL EQUIPMENT		911	683	645
TOTAL LABOUR		665	497	470
TOTAL EQUIPMENT		18210	68325	141955
TOTAL LABOUR		13290	49675	103345
TOTAL PROJECT		31500	118000	245300

SYSTEM - HYBRID #2 SENIORS/SINGLES	STOREY	2	10	22
	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	450	310	300
	POWER WIRING	525	380	360
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	215	145	140
	POWER WIRING	250	190	175
DOMESTIC HOT WATER	BOILERS/STORAGE	170	145	135
	GAS SERVICE PIPING	110	100	95
TOTAL MATRL & LABOUR		1720	1270	1205

SYSTEM - HYBRID #2 SENIORS/SINGLES	STOREY	2	10	22
	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	270	186	180
	POWER WIRING	210	152	144
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	172	116	112
	POWER WIRING	125	95	88
DOMESTIC HOT WATER	BOILERS/STORAGE	111	94	88
	GAS SERVICE PIPING	39	35	33
TOTAL MATERIAL		926	678	645

SYSTEM - HYBRID #2 SENIORS/SINGLES	STOREY	2	10	22
	UNITS	20	100	220
SPACE HEATING	BASEBOARD HEATING	180	124	120
	POWER WIRING	263	190	180
		0	0	0
		0	0	0
		0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	43	29	28
	POWER WIRING	125	95	88
DOMESTIC HOT WATER	BOILERS/STORAGE	59	51	47
	GAS SERVICE PIPING	72	65	62
TOTAL LABOUR		742	554	525

SYSTEM - HYBRID #2	STOREY	2	10	22
SENIORS/SINGLES	UNITS	20	100	220
SPACE HEATING	EQUIPMENT	480	338	324
	LABOUR	443	314	300
CORRIDOR FRESH AIR	EQUIPMENT	297	211	200
	LABOUR	168	124	116
DOMESTIC HOT WATER	EQUIPMENT	149	129	121
	LABOUR	131	116	109
TOTAL EQUIPMENT		926	678	645
TOTAL LABOUR		742	554	525
TOTAL EQUIPMENT		18520	67825	141790
TOTAL LABOUR		14830	55375	115390
TOTAL PROJECT		33350	123200	257180

SYSTEM - ALL GAS FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	GAS BOILER PLANT	2.0	1130	880	830
	GAS SERVICE PIPING	1.5	255	210	203
	WALLFIN RADIATION	2.0	1780	1400	1320
	PIPING/PUMPS/EXP TANK	2.0	1730	1380	1340
	INSULATION	2.0	260	210	210
CORRIDOR FRESH AIR	ROOF TOP UNIT	1.0	260	205	190
	GAS SERVICE PIPING	1.0	35	30	25
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	495	435	405
	GAS SERVICE PIPING	1.5	53	45	38
TOTAL MATRL & LABOUR			5998	4795	4560

SYSTEM - ALL GAS FAMILY	STOREY UNITS	4 40	10 100	22 220
SPACE HEATING	GAS BOILER PLANT	735	572	540
	GAS SERVICE PIPING	89	74	71
	WALLFIN RADIATION	890	700	660
	PIPING/PUMPS/EXP TANK	692	552	536
	INSULATION	169	137	137
CORRIDOR FRESH AIR	ROOF TOP UNIT	208	164	152
	GAS SERVICE PIPING	12	11	9
DOMESTIC HOT WATER	BOILERS/STORAGE	322	283	263
	GAS SERVICE PIPING	18	16	13
TOTAL MATERIAL		3135	2507	2380

SYSTEM - ALL GAS FAMILY	STOREY UNITS	4 40	10 100	22 220
SPACE HEATING	GAS BOILER PLANT	396	308	291
	GAS SERVICE PIPING	166	137	132
	WALLFIN RADIATION	890	700	660
	PIPING/PUMPS/EXP TANK	1038	828	804
	INSULATION	91	74	74
CORRIDOR FRESH AIR	ROOF TOP UNIT	52	41	38
	GAS SERVICE PIPING	23	20	16
DOMESTIC HOT WATER	BOILERS/STORAGE	173	152	142
	GAS SERVICE PIPING	34	29	24
TOTAL LABOUR		2862	2288	2180

* Mutiplication factor to adjust seniors/singles to family building costs.

SYSTEM - ALL GAS	STOREY	2	10	22
FAMILY	UNITS	40	100	220
SPACE HEATING	EQUIPMENT	2575	2034	1943
	LABOUR	2580	2046	1960
CORRIDOR FRESH AIR	EQUIPMENT	220	175	161
	LABOUR	75	61	54
DOMESTIC HOT WATER	EQUIPMENT	340	299	276
	LABOUR	207	182	166
TOTAL EQUIPMENT		3135	2507	2380
TOTAL LABOUR		2862	2288	2180
TOTAL EQUIPMENT		125405	250700	523600
TOTAL LABOUR		114495	228800	479600
TOTAL PROJECT		239900	479500	1003200

SYSTEM - ALL ELECT FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	BASEBOARD HEATING	2.0	890	620	600
	POWER WIRING	1.5	780	570	540
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	1.0	210	145	140
	POWER WIRING	1.0	230	190	175
DOMESTIC HOT WATER	ELECT HEATER/STORAGE	3.0	615	450	435
	POWER WIRING	1.5	413	293	285
TOTAL MATRL & LABOUR			3138	2268	2175

SYSTEM - ALL ELECT FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	BASEBOARD HEATING	2.0	534	372	360
	POWER WIRING	1.5	390	285	270
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	1.0	168	116	112
	POWER WIRING	1.0	115	95	88
DOMESTIC HOT WATER	ELECT HEATER/STORAGE	3.0	400	293	283
	POWER WIRING	1.5	206	146	143
TOTAL MATERIAL			1813	1307	1255

SYSTEM - ALL ELECT FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	BASEBOARD HEATING	2.0	356	248	240
	POWER WIRING	1.5	390	285	270
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	1.0	42	29	28
	POWER WIRING	1.0	115	95	88
DOMESTIC HOT WATER	ELECT HEATER/STORAGE	3.0	215	158	152
	POWER WIRING	1.5	206	146	143
TOTAL LABOUR			1325	961	920

* Mutiplication factor to adjust seniors/singles to family building costs.

SYSTEM - ALL ELECT	STOREY	2	10	22
FAMILY	UNITS	40	100	220
SPACE HEATING	EQUIPMENT	924	657	630
	LABOUR	746	533	510
CORRIDOR FRESH AIR	EQUIPMENT	283	211	200
	LABOUR	157	124	116
DOMESTIC HOT WATER	EQUIPMENT	606	439	425
	LABOUR	422	304	295
TOTAL EQUIPMENT		1813	1307	1255
TOTAL LABOUR		1325	961	920
TOTAL EQUIPMENT		72520	130675	276045
TOTAL LABOUR		52980	96075	202455
TOTAL PROJECT		125500	226750	478500

SYSTEM - HYBRID #1 FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	BASEBOARD HEATING	2.0	910	620	600
	POWER WIRING	1.5	810	570	540
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	ROOF TOP UNIT	1.0	260	205	190
	GAS SERVICE PIPING	1.0	135	110	105
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	525	435	405
	GAS SERVICE PIPING	1.5	53	45	38
TOTAL MATRL & LABOUR			2693	1985	1878

SYSTEM - HYBRID #1 FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	BASEBOARD HEATING	2.0	546	372	360
	POWER WIRING	1.5	405	285	270
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	ROOF TOP UNIT	1.0	208	164	152
	GAS SERVICE PIPING	1.0	47	39	37
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	341	283	263
	GAS SERVICE PIPING	1.5	18	16	13
TOTAL MATERIAL			1566	1158	1095

SYSTEM - HYBRID #1 FAMILY	STOREY UNITS	*	4 40	10 100	22 220
SPACE HEATING	BASEBOARD HEATING	2.0	364	248	240
	POWER WIRING	1.5	405	285	270
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	ROOF TOP UNIT	1.0	52	41	38
	GAS SERVICE PIPING	1.0	88	72	68
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	184	152	142
	GAS SERVICE PIPING	1.5	34	29	24
TOTAL LABOUR			1127	827	782

* Mutiplication factor to adjust seniors/singles to family building costs.

SYSTEM - HYBRID #1	STOREY	2	10	22
FAMILY	UNITS	40	100	220
SPACE HEATING	EQUIPMENT	951	657	630
	LABOUR	769	533	510
CORRIDOR FRESH AIR	EQUIPMENT	255	203	189
	LABOUR	140	113	106
DOMESTIC HOT WATER	EQUIPMENT	360	299	276
	LABOUR	218	182	166
TOTAL EQUIPMENT		1566	1158	1095
TOTAL LABOUR		1127	827	782
TOTAL EQUIPMENT		62635	115800	240928
TOTAL LABOUR		45065	82700	172123
TOTAL PROJECT		107700	198500	413050

SYSTEM - HYBRID #2	STOREY	*	4	10	22
FAMILY	UNITS		40	100	220
SPACE HEATING	BASEBOARD HEATING	2.0	910	620	600
	POWER WIRING	1.5	810	570	540
		1.0	0	0	0
		1.0	0	0	0
		1.0	0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	1.0	210	145	140
	POWER WIRING	1.0	230	190	175
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	525	435	405
	GAS SERVICE PIPING	1.5	165	150	143
TOTAL MATRL & LABOUR			2850	2110	2003

SYSTEM - HYBRID #2	STOREY	*	4	10	22
FAMILY	UNITS		40	100	220
SPACE HEATING	BASEBOARD HEATING	2.0	546	372	360
	POWER WIRING	1.5	324	228	216
		2.0	0	0	0
		2.0	0	0	0
		2.0	0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	1.0	168	116	112
	POWER WIRING	1.0	115	95	88
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	341	283	263
	GAS SERVICE PIPING	1.5	58	53	50
TOTAL MATERIAL			1552	1146	1089

SYSTEM - HYBRID #2	STOREY	*	4	10	22
FAMILY	UNITS		40	100	220
SPACE HEATING	BASEBOARD HEATING	2.0	364	248	240
	POWER WIRING	1.5	405	285	270
		2.0	0	0	0
		2.0	0	0	0
		2.0	0	0	0
CORRIDOR FRESH AIR	AHU/ELEC COIL	1.0	42	29	28
	POWER WIRING	1.0	115	95	88
DOMESTIC HOT WATER	BOILERS/STORAGE	3.0	184	152	142
	GAS SERVICE PIPING	1.5	107	98	93
TOTAL LABOUR			1217	907	860

* Mutiplication factor to adjust seniors/singles to family building costs.

SYSTEM - HYBRID #2	STOREY	2	10	22
FAMILY	UNITS	40	100	220
SPACE HEATING	EQUIPMENT	870	600	576
	LABOUR	769	533	510
CORRIDOR FRESH AIR	EQUIPMENT	283	211	200
	LABOUR	157	124	116
DOMESTIC HOT WATER	EQUIPMENT	399	335	313
	LABOUR	291	250	234
TOTAL EQUIPMENT		1552	1146	1089
TOTAL LABOUR		1217	907	860
TOTAL EQUIPMENT		62080	114625	239498
TOTAL LABOUR		48680	90675	189173
TOTAL PROJECT		110760	205300	428670

3. EQUIPMENT RATED LIFE

EQUIPMENT LIFE

System - All Gas			Equipment Life (years)
I)	Space Heating		
	gas boilers -	forced draft boiler c/w cast iron heat exchanger	30
	wallfin radiation		30
	piping/pumps/exp. tank		30
	insulation		30
II)	Corridor F.A. Heating		
	rooftop unit		20
III)	DHW Heating		
	boilers/storage -	atmospheric boiler c/w copper fin tube heat exchanger and storage	20
System - All Electric			
I)	Space Heating		
	elec. baseboard		20
II)	Corridor F.A. Hating		
	AHU/elec. coil		20
III)	DHW Heating		
	elec. heater/storage -	side arm heater and storage	20

4. EQUIPMENT REPLACEMENT COSTS

EQUIPMENT REPLACEMENT COSTS

Replacement equipment cost *

= installed equipment cost

Replacement equipment labour cost *

= defective equipment removal labour cost
+ installation labour cost

= (0.5 x installation labour cost)
+ installation labour cost

* Whole replacements only.

5. ANNUAL MAINTENANCE COSTS

ANNUAL MAINTENANCE COSTS — ESCALATION = 8.75 % PER YR

SENIORS/SINGLES		A 1980	A 1989	B 1980	B 1989	C 1980	C 1989
ALL GAS	EQPT	$50	$106	$130	$277	$290	$617
	LABOUR	$110	$234	$250	$532	$350	$745
	EQPT-DHW		$120		$180		$240
	LABOUR-DHW		$60		$90		$120
ALL ELEC	EQPT	$20	$43	$30	$64	$40	$85
	LABOUR	$40	$85	$60	$128	$80	$170
	EQPT-DHW		$140		$210		$280
	LABOUR-DHW		$80		$120		$160
HYBRID 1	EQPT	$20	$43	$30	$64	$40	$85
	LABOUR	$40	$85	$60	$128	$80	$170
	EQPT-DHW		$120		$180		$240
	LABOUR-DHW		$60		$90		$120
HYBRID 2	EQPT	$20	$43	$30	$64	$40	$85
	LABOUR	$40	$85	$60	$128	$80	$170
	EQPT-DHW		$120		$180		$240
	LABOUR-DHW		$60		$90		$120

FAMILY		A 1980	A 1989	B 1980	B 1989	C 1980	C 1989
ALL GAS	EQPT	$130	$277	$260	$553	$580	$1,234
	LABOUR	$280	$596	$500	$1,064	$700	$1,489
	EQPT-DHW		$240		$360		$480
	LABOUR-DHW		$70		$110		$150
ALL ELEC	EQPT	$45	$96	$60	$128	$80	$170
	LABOUR	$90	$191	$120	$255	$160	$340
	EQPT-DHW		$280		$420		$560
	LABOUR-DHW		$90		$140		$190
HYBRID 1	EQPT	$45	$96	$60	$128	$80	$170
	LABOUR	$90	$191	$120	$255	$160	$340
	EQPT-DHW		$240		$360		$480
	LABOUR-DHW		$70		$110		$150
HYBRID 2	EQPT	$45	$96	$60	$128	$80	$170
	LABOUR	$90	$191	$120	$255	$160	$340
	EQPT-DHW		$240		$360		$480
	LABOUR-DHW		$70		$110		$150

TOTALS	SENIORS/SINGLES			
ALL GAS	EQPT	$226	$457	$857
	LABOUR	$294	$622	$865
ALL ELEC	EQPT	$183	$274	$365
	LABOUR	$165	$248	$330
HYBRID 1	EQPT	$163	$244	$325
	LABOUR	$145	$218	$290
HYBRID 2	EQPT	$163	$244	$325
	LABOUR	$145	$218	$290

TOTALS	FAMILY			
ALL GAS	EQPT	$517	$913	$1,714
	LABOUR	$666	$1,174	$1,639
ALL ELEC	EQPT	$376	$548	$730
	LABOUR	$281	$395	$530
HYBRID 1	EQPT	$336	$488	$650
	LABOUR	$261	$365	$490
HYBRID 2	EQPT	$336	$488	$650
	LABOUR	$261	$365	$490

APPENDIX D RESULTS OF LIFE CYCLE COSTING ANALYSIS

LIFE CYCLE COSTING ANALYSIS FOR BUILDING SYSTEMS

BUILDING DATA	BUILDING TYPE (ID 1-2)	2 SENIORS/SINGLES
	LOCATION (ID 1-9)	1 NORTH YORK
	HEATING DEGREE DAYS	6827 (deg F)
	BLDG LIFE EXPECTANCY	60 (years)
	DISCOUNT RATE	10 (%/year)
	DE-REG GAS DISCOUNT	7 (%)
ESCALATION RATES	EQUIPMENT/MATERIAL	8 (%/year)
	LABOUR	8 (%/year)
	ELECT	6 (%/year)
	GAS	4 (%/year)

NOTE : ALL COSTS ARE BASED ON TORONTO 1989 DOLLARS.
COSTS FOR OTHER LOCATIONS ARE ESCALATED AS REQUIRED.

BUILDING TYPE DESCRIPTIONS

BUILDING TYPE	A	B	C
TOTAL STOREYS	2	10	22
SUITES PER FLOOR	10	10	10
TOTAL SUITES	20	100	220
TOTAL BUILDING AREA (sqft) (C/W CORRIDORS, LESS GARAGE)	10780	53900	118580
UNHEATED GARAGE AREA (sqft)	0	41000	90000

INSTALLATION COSTS *

BUILDING TYPE		A	B	C
ALL GAS	EQUIPMENT	$33,320	$130,900	$273,020
	LABOUR	$29,900	$117,700	$246,400
	COMMISSIONING	$0	$0	$0
ALL ELECT	EQUIPMENT	$22,120	$78,200	$164,780
	LABOUR	$16,480	$58,800	$123,420
	COMMISSIONING	$0	$0	$0
HYBRID 1	EQUIPMENT	$18,220	$68,300	$141,900
	LABOUR	$13,300	$49,700	$103,400
	COMMISSIONING	$0	$0	$0
HYBRID 2	EQUIPMENT	$18,520	$67,800	$141,900
	LABOUR	$14,840	$55,400	$115,500
	COMMISSIONING	$0	$0	$0

EQUIPMENT RATED LIFE (YEARS)

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	30	30	30
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
ALL ELECT	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 1	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 2	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20

EQUIPMENT REPLACEMENT COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$26,420	$102,900	$216,260
	CORRIDOR F/A	$4,440	$17,500	$35,420
	DHW HEATING	$2,460	$10,500	$21,340
ALL ELECT	SPACE HEATING	$10,660	$37,600	$79,200
	CORRIDOR F/A	$5,940	$21,100	$44,000
	DHW HEATING	$5,540	$19,500	$41,580
HYBRID 1	SPACE HEATING	$10,660	$37,600	$79,200
	CORRIDOR F/A	$5,100	$20,300	$41,580
	DHW HEATING	$2,460	$10,500	$21,340
HYBRID 2	SPACE HEATING	$9,600	$33,800	$71,280
	CORRIDOR F/A	$5,940	$21,100	$44,000
	DHW HEATING	$2,980	$12,900	$26,620

EQUIPMENT REPLACEMENT LABOUR COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$40,020	$156,900	$330,660
	CORRIDOR F/A	$2,340	$9,150	$17,820
	DHW HEATING	$2,460	$10,500	$21,120
ALL ELECT	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$5,040	$18,600	$38,280
	DHW HEATING	$6,420	$22,500	$48,180
HYBRID 1	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$4,200	$16,950	$34,980
	DHW HEATING	$2,460	$10,500	$21,120
HYBRID 2	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$5,040	$18,600	$38,280
	DHW HEATING	$3,930	$17,400	$35,970

ANNUAL ELECTRICITY AND GAS USE SUMMARY **

BUILDING TYPE		A	B	C
ALL GAS	ELEC KWH	136,194	757,301	1,666,673
	GAS EKWH	172,193	790,140	1,787,646
	EKWH/SQFT/YR	28.6	28.7	29.1
ALL ELECT	ELEC KWH	233,750	1,192,150	2,655,000
	GAS EKWH	0	0	0
	EKWH/SQFT/YR	21.7	22.1	22.4
HYBRID 1	ELEC KWH	189,528	988,162	2,207,164
	GAS EKWH	59,821	278,200	610,792
	EKWH/SQFT/YR	23.1	23.5	23.8
HYBRID 2	ELEC KWH	214,337	1,112,528	2,480,133
	GAS EKWH	23,899	98,134	215,488
	EKWH/SQFT/YR	22.1	22.5	22.7

ANNUAL ELECTRICITY AND GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	GAS	$3,000	$12,550	$27,700
ALL ELECT	ELECT	$5,000	$21,500	$48,400
	GAS	$0	$0	$0
HYBRID 1	ELECT	$2,750	$12,300	$28,200
	GAS	$1,150	$4,750	$9,900
HYBRID 2	ELECT	$4,200	$19,000	$42,900
	GAS	$500	$1,800	$3,800

ANNUAL ELECTRICITY AND DE-REG GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	DE-REG GAS	$2,790	$11,672	$25,761
ALL ELECT	ELECT	$5,000	$21,500	$48,400
	DE-REG GAS	$0	$0	$0
HYBRID 1	ELECT	$2,750	$12,300	$28,200
	DE-REG GAS	$1,070	$4,418	$9,207
HYBRID 2	ELECT	$4,200	$19,000	$42,900
	DE-REG GAS	$465	$1,674	$3,534

ANNUAL MAINTENANCE COSTS *

BUILDING TYPE		A	B	C
ALL GAS	MATERIAL	$226	$457	$857
	LABOUR	$294	$622	$865
ALL ELECT	MATERIAL	$183	$274	$365
	LABOUR	$165	$248	$330
HYBRID 1	MATERIAL	$163	$244	$325
	LABOUR	$145	$218	$290
HYBRID 2	MATERIAL	$163	$244	$325
	LABOUR	$145	$218	$290

LIFE CYCLE COSTS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$184,202	$703,213	$1,472,664
	PER SUITE	$9,210	$7,032	$6,694
	PER SQFT	$17.09	$13.05	$12.42
ALL ELECT	TOTAL	$224,281	$858,995	$1,867,661
	PER SUITE	$11,214	$8,590	$8,489
	PER SQFT	$20.81	$15.94	$15.75
HYBRID 1	TOTAL	$171,612	$672,432	$1,448,061
	PER SUITE	$8,581	$6,724	$6,582
	PER SQFT	$15.92	$12.48	$12.21
HYBRID 2	TOTAL	$199,898	$795,903	$1,726,455
	PER SUITE	$9,995	$7,959	$7,848
	PER SQFT	$18.54	$14.77	$14.56

LIFE CYCLE COSTS WITH DE-REG GAS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$180,687	$688,511	$1,440,216
	PER SUITE	$9,034	$6,885	$6,546
	PER SQFT	$16.76	$12.77	$12.15
ALL ELECT	TOTAL	$224,281	$858,995	$1,867,661
	PER SUITE	$11,214	$8,590	$8,489
	PER SQFT	$20.81	$15.94	$15.75
HYBRID 1	TOTAL	$170,265	$666,867	$1,436,464
	PER SUITE	$8,513	$6,669	$6,529
	PER SQFT	$15.79	$12.37	$12.11
HYBRID 2	TOTAL	$199,312	$793,795	$1,722,004
	PER SUITE	$9,966	$7,938	$7,827
	PER SQFT	$18.49	$14.73	$14.52

NOTES : * EQUIPMENT WHICH IS NOT COMMON TO BOTH GAS & ELECTRIC SPACE, CORRIDOR FRESH AIR & DHW HEATING SYSTEMS.

** TOTAL ENERGY USED FOR SPACE, CORRIDOR FRESH AIR AND DHW HEATING, COOLING, FANS & PUMPS, ELECTRICAL EQUIPMENT AND LIGHTING. SQ FT USED IS TOTAL BUILDING AREA.

*** ENERGY COSTS FOR SPACE, CORRIDOR FRESH AIR & DHW HEATING ONLY.

**** SQ FT USED IS TOTAL BUILDING AREA.

LIFE CYCLE COSTING ANALYSIS FOR BUILDING SYSTEMS

BUILDING DATA	:BUILDING TYPE (ID 1-2)	1 FAMILY
	LOCATION (ID 1-9)	1 NORTH YORK
	HEATING DEGREE DAYS	6827 (deg F)
	BLDG LIFE EXPECTANCY	60 (years)
	DISCOUNT RATE	10 (%/year)
	DE-REG GAS DISCOUNT	7 (%)
ESCALATION RATES	:EQUIPMENT/MATERIAL	8 (%/year)
	LABOUR	8 (%/year)
	ELECT	6 (%/year)
	GAS	4 (%/year)

NOTE : ALL COSTS ARE BASED ON TORONTO 1989 DOLLARS.
COSTS FOR OTHER LOCATIONS ARE ESCALATED AS REQUIRED.

BUILDING TYPE DESCRIPTIONS

BUILDING TYPE	A	B	C
TOTAL STOREYS	4	10	22
SUITES PER FLOOR	10	10	10
TOTAL SUITES	40	100	220
TOTAL BUILDING AREA (sqft) (C/W CORRIDORS, LESS GARAGE)	50600	126500	278300
UNHEATED GARAGE AREA (sqft)	16000	41000	90000

INSTALLATION COSTS *

BUILDING TYPE		A	B	C
ALL GAS	EQUIPMENT	$125,400	$250,700	$523,600
	LABOUR	$114,480	$228,800	$479,600
	COMMISSIONING	$0	$0	$0
ALL ELECT	EQUIPMENT	$72,520	$130,700	$276,100
	LABOUR	$53,000	$96,100	$202,400
	COMMISSIONING	$0	$0	$0
HYBRID 1	EQUIPMENT	$62,640	$115,800	$240,900
	LABOUR	$45,080	$82,700	$172,040
	COMMISSIONING	$0	$0	$0
HYBRID 2	EQUIPMENT	$62,080	$114,600	$239,580
	LABOUR	$48,680	$90,700	$189,200
	COMMISSIONING	$0	$0	$0

EQUIPMENT RATED LIFE (YEARS)

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	30	30	30
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
ALL ELECT	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 1	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 2	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20

EQUIPMENT REPLACEMENT COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$103,000	$203,400	$427,460
	CORRIDOR F/A	$8,800	$17,500	$35,420
	DHW HEATING	$13,600	$29,900	$60,720
ALL ELECT	SPACE HEATING	$36,960	$65,700	$138,600
	CORRIDOR F/A	$11,320	$21,100	$44,000
	DHW HEATING	$24,240	$43,900	$93,500
HYBRID 1	SPACE HEATING	$38,040	$65,700	$138,600
	CORRIDOR F/A	$10,200	$20,300	$41,580
	DHW HEATING	$14,400	$29,900	$21,340
HYBRID 2	SPACE HEATING	$34,800	$60,000	$126,720
	CORRIDOR F/A	$11,320	$21,100	$44,000
	DHW HEATING	$15,960	$33,500	$68,860

EQUIPMENT REPLACEMENT LABOUR COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$154,800	$306,900	$646,800
	CORRIDOR F/A	$4,500	$9,150	$17,820
	DHW HEATING	$12,420	$27,300	$54,780
ALL ELECT	SPACE HEATING	$44,760	$79,950	$168,300
	CORRIDOR F/A	$9,420	$18,600	$38,280
	DHW HEATING	$25,320	$45,600	$97,350
HYBRID 1	SPACE HEATING	$46,140	$79,950	$168,300
	CORRIDOR F/A	$8,400	$16,950	$34,980
	DHW HEATING	$13,080	$27,300	$54,780
HYBRID 2	SPACE HEATING	$46,140	$79,950	$168,300
	CORRIDOR F/A	$9,420	$18,600	$38,280
	DHW HEATING	$17,460	$37,500	$77,220

ANNUAL ELECTRICITY AND GAS USE SUMMARY **

BUILDING TYPE		A	B	C
ALL GAS	ELEC KWH	592,232	1,475,105	3,254,230
	GAS EKWH	512,350	1,124,947	2,649,795
	EKWH/SQFT/YR	21.8	20.6	21.2
ALL ELECT	ELEC KWH	893,800	2,148,050	4,789,850
	GAS EKWH	0	0	0
	EKWH/SQFT/YR	17.7	17.0	17.2
HYBRID 1	ELEC KWH	736,525	1,759,014	3,937,401
	GAS EKWH	204,693	505,773	1,108,328
	EKWH/SQFT/YR	18.6	17.9	18.1
HYBRID 2	ELEC KWH	758,627	1,879,589	4,201,039
	GAS EKWH	133,286	330,824	725,598
	EKWH/SQFT/YR	17.6	17.5	17.7

ANNUAL ELECTRICITY AND GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	GAS	$8,350	$17,700	$40,750
ALL ELECT	ELECT	$13,000	$29,700	$66,850
	GAS	$0	$0	$0
HYBRID 1	ELECT	$6,950	$14,750	$34,700
	GAS	$3,600	$8,350	$17,450
HYBRID 2	ELECT	$9,650	$21,300	$49,050
	GAS	$2,400	$5,650	$11,650

ANNUAL ELECTRICITY AND DE-REG GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	DE-REG GAS	$7,765	$16,461	$37,898
ALL ELECT	ELECT	$13,000	$29,700	$66,850
	DE-REG GAS	$0	$0	$0
HYBRID 1	ELECT	$6,950	$14,750	$34,700
	DE-REG GAS	$3,348	$7,765	$16,228
HYBRID 2	ELECT	$9,650	$21,300	$49,050
	DE-REG GAS	$2,232	$5,255	$10,835

ANNUAL MAINTENANCE COSTS *

BUILDING TYPE		A	B	C
ALL GAS	MATERIAL	$517	$913	$1,714
	LABOUR	$666	$1,174	$1,639
ALL ELECT	MATERIAL	$376	$548	$730
	LABOUR	$281	$395	$530
HYBRID 1	MATERIAL	$336	$488	$650
	LABOUR	$261	$365	$490
HYBRID 2	MATERIAL	$336	$488	$650
	LABOUR	$261	$365	$490

LIFE CYCLE COSTS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$617,033	$1,243,539	$2,623,381
	PER SUITE	$15,426	$12,435	$11,924
	PER SQFT	$12.19	$9.83	$9.43
ALL ELECT	TOTAL	$634,669	$1,284,919	$2,783,783
	PER SUITE	$15,867	$12,849	$12,654
	PER SQFT	$12.54	$10.16	$10.00
HYBRID 1	TOTAL	$506,475	$999,099	$2,104,976
	PER SUITE	$12,662	$9,991	$9,568
	PER SQFT	$10.01	$7.90	$7.56
HYBRID 2	TOTAL	$558,908	$1,127,859	$2,437,658
	PER SUITE	$13,973	$11,279	$11,080
	PER SQFT	$11.05	$8.92	$8.76

LIFE CYCLE COSTS WITH DE-REG GAS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$607,252	$1,222,805	$2,575,646
	PER SUITE	$15,181	$12,228	$11,707
	PER SQFT	$12.00	$9.67	$9.25
ALL ELECT	TOTAL	$634,669	$1,284,919	$2,783,783
	PER SUITE	$15,867	$12,849	$12,654
	PER SQFT	$12.54	$10.16	$10.00
HYBRID 1	TOTAL	$502,257	$989,318	$2,084,535
	PER SUITE	$12,556	$9,893	$9,475
	PER SQFT	$9.93	$7.82	$7.49
HYBRID 2	TOTAL	$556,096	$1,121,241	$2,424,011
	PER SUITE	$13,902	$11,212	$11,018
	PER SQFT	$10.99	$8.86	$8.71

NOTES : * EQUIPMENT WHICH IS NOT COMMON TO BOTH GAS & ELECTRIC SPACE, CORRIDOR FRESH AIR & DHW HEATING SYSTEMS.

** TOTAL ENERGY USED FOR SPACE, CORRIDOR FRESH AIR AND DHW HEATING, COOLING, FANS & PUMPS, ELECTRICAL EQUIPMENT AND LIGHTING. SQ FT USED IS TOTAL BUILDING AREA.

*** ENERGY COSTS FOR SPACE, CORRIDOR FRESH AIR & DHW HEATING ONLY.

**** SQ FT USED IS TOTAL BUILDING AREA.

LIFE CYCLE COSTING ANALYSIS FOR BUILDING SYSTEMS

BUILDING DATA	:BUILDING TYPE (ID 1-2)	2 SENIORS/SINGLES
	LOCATION (ID 1-9)	5 THUNDERBAY
	HEATING DEGREE DAYS	10405 (deg F)
	BLDG LIFE EXPECTANCY	60 (years)
	DISCOUNT RATE	10 (%/year)
	DE-REG GAS DISCOUNT	7 (%)
ESCALATION RATES	:EQUIPMENT/MATERIAL	8 (%/year)
	LABOUR	8 (%/year)
	ELECT	6 (%/year)
	GAS	4 (%/year)

NOTE : ALL COSTS ARE BASED ON TORONTO 1989 DOLLARS.
COSTS FOR OTHER LOCATIONS ARE ESCALATED AS REQUIRED.

BUILDING TYPE DESCRIPTIONS

BUILDING TYPE	A	B	C
TOTAL STOREYS	2	10	22
SUITES PER FLOOR	10	10	10
TOTAL SUITES	20	100	220
TOTAL BUILDING AREA (sqft) (C/W CORRIDORS, LESS GARAGE)	10780	53900	118580
UNHEATED GARAGE AREA (sqft)	0	41000	90000

INSTALLATION COSTS *

BUILDING TYPE		A	B	C
ALL GAS	EQUIPMENT	$33,320	$130,900	$273,020
	LABOUR	$29,900	$117,700	$246,400
	COMMISSIONING	$0	$0	$0
ALL ELECT	EQUIPMENT	$22,120	$78,200	$164,780
	LABOUR	$16,480	$58,800	$123,420
	COMMISSIONING	$0	$0	$0
HYBRID 1	EQUIPMENT	$18,220	$68,300	$141,900
	LABOUR	$13,300	$49,700	$103,400
	COMMISSIONING	$0	$0	$0
HYBRID 2	EQUIPMENT	$18,520	$67,800	$141,900
	LABOUR	$14,840	$55,400	$115,500
	COMMISSIONING	$0	$0	$0

EQUIPMENT RATED LIFE (YEARS)

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	30	30	30
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
ALL ELECT	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 1	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 2	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20

EQUIPMENT REPLACEMENT COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$26,420	$102,900	$216,260
	CORRIDOR F/A	$4,440	$17,500	$35,420
	DHW HEATING	$2,460	$10,500	$21,340
ALL ELECT	SPACE HEATING	$10,660	$37,600	$79,200
	CORRIDOR F/A	$5,940	$21,100	$44,000
	DHW HEATING	$5,540	$19,500	$41,580
HYBRID 1	SPACE HEATING	$10,660	$37,600	$79,200
	CORRIDOR F/A	$5,100	$20,300	$41,580
	DHW HEATING	$2,460	$10,500	$21,340
HYBRID 2	SPACE HEATING	$9,600	$33,800	$71,280
	CORRIDOR F/A	$5,940	$21,100	$44,000
	DHW HEATING	$2,980	$12,900	$26,620

EQUIPMENT REPLACEMENT LABOUR COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$40,020	$156,900	$330,660
	CORRIDOR F/A	$2,340	$9,150	$17,820
	DHW HEATING	$2,460	$10,500	$21,120
ALL ELECT	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$5,040	$18,600	$38,280
	DHW HEATING	$6,420	$22,500	$48,180
HYBRID 1	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$4,200	$16,950	$34,980
	DHW HEATING	$2,460	$10,500	$21,120
HYBRID 2	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$5,040	$18,600	$38,280
	DHW HEATING	$3,930	$17,400	$35,970

ANNUAL ELECTRICITY AND GAS USE SUMMARY **

BUILDING TYPE		A	B	C
ALL GAS	ELEC KWH	138,655	766,379	1,690,636
	GAS EKWH	252,585	1,142,669	2,620,665
	EKWH/SQFT/YR	36.3	35.4	36.4
ALL ELECT	ELEC KWH	277,600	1,395,300	3,119,400
	GAS EKWH	0	0	0
	EKWH/SQFT/YR	25.8	25.9	26.3
HYBRID 1	ELEC KWH	221,411	1,133,327	2,544,030
	GAS EKWH	77,366	363,480	797,826
	EKWH/SQFT/YR	27.7	27.8	28.2
HYBRID 2	ELEC KWH	256,447	1,308,350	2,928,388
	GAS EKWH	26,083	107,120	235,352
	EKWH/SQFT/YR	26.2	26.3	26.7

ANNUAL ELECTRICITY AND GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	GAS	$4,500	$19,500	$43,300
ALL ELECT	ELECT	$6,850	$31,300	$70,450
	GAS	$0	$0	$0
HYBRID 1	ELECT	$4,050	$18,850	$43,150
	GAS	$1,450	$6,350	$13,650
HYBRID 2	ELECT	$6,050	$28,650	$64,650
	GAS	$450	$1,900	$4,000

ANNUAL ELECTRICITY AND DE-REG GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	DE-REG GAS	$4,185	$18,135	$40,269
ALL ELECT	ELECT	$6,850	$31,300	$70,450
	DE-REG GAS	$0	$0	$0
HYBRID 1	ELECT	$4,050	$18,850	$43,150
	DE-REG GAS	$1,349	$5,906	$12,695
HYBRID 2	ELECT	$6,050	$28,650	$64,650
	DE-REG GAS	$419	$1,767	$3,720

ANNUAL MAINTENANCE COSTS *

BUILDING TYPE		A	B	C
ALL GAS	MATERIAL	$226	$457	$857
	LABOUR	$294	$622	$865
ALL ELECT	MATERIAL	$183	$274	$365
	LABOUR	$165	$248	$330
HYBRID 1	MATERIAL	$163	$244	$325
	LABOUR	$145	$218	$290
HYBRID 2	MATERIAL	$163	$244	$325
	LABOUR	$145	$218	$290

LIFE CYCLE COSTS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$225,000	$877,151	$1,850,989
	PER SUITE	$11,250	$8,772	$8,414
	PER SQFT	$20.87	$16.27	$15.61
ALL ELECT	TOTAL	$279,991	$1,130,361	$2,470,749
	PER SUITE	$14,000	$11,304	$11,231
	PER SQFT	$25.97	$20.97	$20.84
HYBRID 1	TOTAL	$217,169	$887,941	$1,933,319
	PER SUITE	$10,858	$8,879	$8,788
	PER SQFT	$20.15	$16.47	$16.30
HYBRID 2	TOTAL	$253,391	$1,062,331	$2,318,980
	PER SUITE	$12,670	$10,623	$10,541
	PER SQFT	$23.51	$19.71	$19.56

LIFE CYCLE COSTS WITH DE-REG GAS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$219,729	$854,308	$1,800,267
	PER SUITE	$10,986	$8,543	$8,183
	PER SQFT	$20.38	$15.85	$15.18
ALL ELECT	TOTAL	$279,991	$1,130,361	$2,470,749
	PER SUITE	$14,000	$11,304	$11,231
	PER SQFT	$25.97	$20.97	$20.84
HYBRID 1	TOTAL	$215,471	$880,502	$1,917,330
	PER SUITE	$10,774	$8,805	$8,715
	PER SQFT	$19.99	$16.34	$16.17
HYBRID 2	TOTAL	$252,864	$1,060,105	$2,314,294
	PER SUITE	$12,643	$10,601	$10,520
	PER SQFT	$23.46	$19.67	$19.52

NOTES : * EQUIPMENT WHICH IS NOT COMMON TO BOTH GAS & ELECTRIC SPACE, CORRIDOR FRESH AIR & DHW HEATING SYSTEMS.

** TOTAL ENERGY USED FOR SPACE, CORRIDOR FRESH AIR AND DHW HEATING, COOLING, FANS & PUMPS, ELECTRICAL EQUIPMENT AND LIGHTING. SQ FT USED IS TOTAL BUILDING AREA.

*** ENERGY COSTS FOR SPACE, CORRIDOR FRESH AIR & DHW HEATING ONLY.

**** SQ FT USED IS TOTAL BUILDING AREA.

LIFE CYCLE COSTING ANALYSIS FOR BUILDING SYSTEMS

BUILDING DATA :	BUILDING TYPE (ID 1-2)	1 FAMILY
	LOCATION (ID 1-9)	5 THUNDERBAY
	HEATING DEGREE DAYS	10405 (deg F)
	BLDG LIFE EXPECTANCY	60 (years)
	DISCOUNT RATE	10 (%/year)
	DE-REG GAS DISCOUNT	7 (%)
ESCALATION RATES :	EQUIPMENT/MATERIAL	8 (%/year)
	LABOUR	8 (%/year)
	ELECT	6 (%/year)
	GAS	4 (%/year)

NOTE : ALL COSTS ARE BASED ON TORONTO 1989 DOLLARS.
COSTS FOR OTHER LOCATIONS ARE ESCALATED AS REQUIRED.

BUILDING TYPE DESCRIPTIONS

BUILDING TYPE	A	B	C
TOTAL STOREYS	4	10	22
SUITES PER FLOOR	10	10	10
TOTAL SUITES	40	100	220
TOTAL BUILDING AREA (sqft) (C/W CORRIDORS, LESS GARAGE)	50600	126500	278300
UNHEATED GARAGE AREA (sqft)	16000	41000	90000

INSTALLATION COSTS *

BUILDING TYPE		A	B	C
ALL GAS	EQUIPMENT	$125,400	$250,700	$523,600
	LABOUR	$114,480	$228,800	$479,600
	COMMISSIONING	$0	$0	$0
ALL ELECT	EQUIPMENT	$72,520	$130,700	$276,100
	LABOUR	$53,000	$96,100	$202,400
	COMMISSIONING	$0	$0	$0
HYBRID 1	EQUIPMENT	$62,640	$115,800	$240,900
	LABOUR	$45,080	$82,700	$172,040
	COMMISSIONING	$0	$0	$0
HYBRID 2	EQUIPMENT	$62,080	$114,600	$239,580
	LABOUR	$48,680	$90,700	$189,200
	COMMISSIONING	$0	$0	$0

EQUIPMENT RATED LIFE (YEARS)

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	30	30	30
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
ALL ELECT	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 1	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 2	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20

EQUIPMENT REPLACEMENT COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$103,000	$203,400	$427,460
	CORRIDOR F/A	$8,800	$17,500	$35,420
	DHW HEATING	$13,600	$29,900	$60,720
ALL ELECT	SPACE HEATING	$36,960	$65,700	$138,600
	CORRIDOR F/A	$11,320	$21,100	$44,000
	DHW HEATING	$24,240	$43,900	$93,500
HYBRID 1	SPACE HEATING	$38,040	$65,700	$138,600
	CORRIDOR F/A	$10,200	$20,300	$41,580
	DHW HEATING	$14,400	$29,900	$21,340
HYBRID 2	SPACE HEATING	$34,800	$60,000	$126,720
	CORRIDOR F/A	$11,320	$21,100	$44,000
	DHW HEATING	$15,960	$33,500	$68,860

EQUIPMENT REPLACEMENT LABOUR COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$154,800	$306,900	$646,800
	CORRIDOR F/A	$4,500	$9,150	$17,820
	DHW HEATING	$12,420	$27,300	$54,780
ALL ELECT	SPACE HEATING	$44,760	$79,950	$168,300
	CORRIDOR F/A	$9,420	$18,600	$38,280
	DHW HEATING	$25,320	$45,600	$97,350
HYBRID 1	SPACE HEATING	$46,140	$79,950	$168,300
	CORRIDOR F/A	$8,400	$16,950	$34,980
	DHW HEATING	$13,080	$27,300	$54,780
HYBRID 2	SPACE HEATING	$46,140	$79,950	$168,300
	CORRIDOR F/A	$9,420	$18,600	$38,280
	DHW HEATING	$17,460	$37,500	$77,220

ANNUAL ELECTRICITY AND GAS USE SUMMARY **

BUILDING TYPE		A	B	C
ALL GAS	ELEC KWH	598,300	1,488,719	3,276,871
	GAS EKWH	773,042	1,729,187	3,912,542
	EKWH/SQFT/YR	27.1	25.4	25.8
ALL ELECT	ELEC KWH	1,033,100	2,470,950	5,509,550
	GAS EKWH	0	0	0
	EKWH/SQFT/YR	20.4	19.5	19.8
HYBRID 1	ELEC KWH	844,547	2,007,058	4,493,215
	GAS EKWH	249,829	611,499	1,339,936
	EKWH/SQFT/YR	21.6	20.7	21.0
HYBRID 2	ELEC KWH	915,044	2,177,987	4,866,894
	GAS EKWH	145,454	360,974	791,887
	EKWH/SQFT/YR	21.0	20.1	20.3

ANNUAL ELECTRICITY AND GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	GAS	$13,350	$29,000	$63,550
ALL ELECT	ELECT	$18,900	$43,600	$97,750
	GAS	$0	$0	$0
HYBRID 1	ELECT	$11,350	$25,100	$57,850
	GAS	$4,350	$10,350	$22,150
HYBRID 2	ELECT	$15,300	$34,700	$78,950
	GAS	$2,550	$6,050	$12,950

ANNUAL ELECTRICITY AND DE-REG GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	DE-REG GAS	$12,416	$26,970	$59,101
ALL ELECT	ELECT	$18,900	$43,600	$97,750
	DE-REG GAS	$0	$0	$0
HYBRID 1	ELECT	$11,350	$25,100	$57,850
	DE-REG GAS	$4,045	$9,626	$20,600
HYBRID 2	ELECT	$15,300	$34,700	$78,950
	DE-REG GAS	$2,372	$5,627	$12,044

ANNUAL MAINTENANCE COSTS *

BUILDING TYPE		A	B	C
ALL GAS	MATERIAL	$517	$913	$1,714
	LABOUR	$666	$1,174	$1,639
ALL ELECT	MATERIAL	$376	$548	$730
	LABOUR	$281	$395	$530
HYBRID 1	MATERIAL	$336	$488	$650
	LABOUR	$261	$365	$490
HYBRID 2	MATERIAL	$336	$488	$650
	LABOUR	$261	$365	$490

LIFE CYCLE COSTS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$756,758	$1,543,815	$3,231,586
	PER SUITE	$18,919	$15,438	$14,689
	PER SQFT	$14.96	$12.20	$11.61
ALL ELECT	TOTAL	$810,782	$1,678,840	$3,649,262
	PER SUITE	$20,270	$16,788	$16,588
	PER SQFT	$16.02	$13.27	$13.11
HYBRID 1	TOTAL	$654,486	$1,334,067	$2,844,297
	PER SUITE	$16,362	$13,341	$12,929
	PER SQFT	$12.93	$10.55	$10.22
HYBRID 2	TOTAL	$728,142	$1,511,926	$3,290,266
	PER SUITE	$18,204	$15,119	$14,956
	PER SQFT	$14.39	$11.95	$11.82

LIFE CYCLE COSTS WITH DE-REG GAS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$741,120	$1,509,844	$3,157,143
	PER SUITE	$18,528	$15,098	$14,351
	PER SQFT	$14.65	$11.94	$11.34
ALL ELECT	TOTAL	$810,782	$1,678,840	$3,649,262
	PER SUITE	$20,270	$16,788	$16,588
	PER SQFT	$16.02	$13.27	$13.11
HYBRID 1	TOTAL	$649,391	$1,321,943	$2,818,351
	PER SUITE	$16,235	$13,219	$12,811
	PER SQFT	$12.83	$10.45	$10.13
HYBRID 2	TOTAL	$725,155	$1,504,839	$3,275,097
	PER SUITE	$18,129	$15,048	$14,887
	PER SQFT	$14.33	$11.90	$11.77

NOTES : * EQUIPMENT WHICH IS NOT COMMON TO BOTH GAS & ELECTRIC SPACE, CORRIDOR FRESH AIR & DHW HEATING SYSTEMS.

** TOTAL ENERGY USED FOR SPACE, CORRIDOR FRESH AIR AND DHW HEATING, COOLING, FANS & PUMPS, ELECTRICAL EQUIPMENT AND LIGHTING. SQ FT USED IS TOTAL BUILDING AREA.

*** ENERGY COSTS FOR SPACE, CORRIDOR FRESH AIR & DHW HEATING ONLY.

**** SQ FT USED IS TOTAL BUILDING AREA.

APPENDIX E LIFE CYCLE COSTING SPREADSHEET DOCUMENTATION

LIFE CYCLE COSTING ANALYSIS FOR BUILDING SYSTEMS

				Instructions
BUILDING DATA	:BUILDING TYPE (ID 1-2)	2 SENIORS/SINGLES	<------	Enter building type.
	LOCATION (ID 1-9)	5 THUNDERBAY	<------	Enter city code.
	HEATING DEGREE DAYS	10405 (deg F)	------>	Degree days provided for city selected.
	BLDG LIFE EXPECTANCY	60 (years)	<------	Enter building life.
	DISCOUNT RATE	10 (%/year)	<------	Enter discount rate.
	DE-REG GAS DISCOUNT	7 (%)	<------	Enter de-regulated gas discount.
ESCALATION RATES	:EQUIPMENT/MATERIAL	8 (%/year)	<------	Enter material escalation rate.
	LABOUR	8 (%/year)	<------	Enter labour escalation rate.
	ELECT	6 (%/year)	<------	Enter electricity escalation rate.
	GAS	4 (%/year)	<------	Enter gas escalation rate.

NOTE : ALL COSTS ARE BASED ON TORONTO 1989 DOLLARS.
COSTS FOR OTHER LOCATIONS ARE ESCALATED AS REQUIRED.

BUILDING TYPE DESCRIPTIONS

BUILDING TYPE	A	B	C	
TOTAL STOREYS	2	10	22	------> Storeys provided for building type.
SUITES PER FLOOR	10	10	10	------> Suites per floor set at 10.
TOTAL SUITES	20	100	220	------> Suites provided for building type.
TOTAL BUILDING AREA (sqft) (C/W CORRIDORS, LESS GARAGE)	10780	53900	118580	------> Building area provided for building type.
UNHEATED GARAGE AREA (sqft)	0	41000	90000	------> Garage area provided for building type.

INSTALLATION COSTS *

BUILDING TYPE		A	B	C	
ALL GAS	EQUIPMENT	$33,320	$130,900	$273,020	------> Equipment and labour installation costs provided for building type.
	LABOUR	$29,900	$117,700	$246,400	
	COMMISSIONING	$0	$0	$0	<------ Enter cost for commissioning.
ALL ELECT	EQUIPMENT	$22,120	$78,200	$164,780	
	LABOUR	$16,480	$58,800	$123,120	
	COMMISSIONING	$0	$0	$0	
HYBRID 1	EQUIPMENT	$18,220	$68,300	$141,900	
	LABOUR	$13,300	$49,700	$103,400	
	COMMISSIONING	$0	$0	$0	
HYBRID 2	EQUIPMENT	$18,520	$67,800	$141,900	
	LABOUR	$14,840	$55,400	$115,500	
	COMMISSIONING	$0	$0	$0	

EQUIPMENT RATED LIFE (YEARS)

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	30	30	30
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
ALL ELECT	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 1	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20
HYBRID 2	SPACE HEATING	20	20	20
	CORRIDOR F/A	20	20	20
	DHW HEATING	20	20	20

<------ Enter space heating, corridor f/a and domestic hot water system rated lives in years.

EQUIPMENT REPLACEMENT COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$26,420	$102,900	$216,260
	CORRIDOR F/A	$4,440	$17,500	$35,420
	DHW HEATING	$2,460	$10,500	$21,340
ALL ELECT	SPACE HEATING	$10,660	$37,600	$79,200
	CORRIDOR F/A	$5,940	$21,100	$44,000
	DHW HEATING	$5,540	$19,500	$41,580
HYBRID 1	SPACE HEATING	$10,660	$37,600	$79,200
	CORRIDOR F/A	$5,100	$20,300	$41,580
	DHW HEATING	$2,460	$10,500	$21,340
HYBRID 2	SPACE HEATING	$9,600	$33,800	$71,280
	CORRIDOR F/A	$5,940	$21,100	$44,000
	DHW HEATING	$2,980	$12,900	$26,620

------> Space heating, corridor f/a and domestic hot water system equipment replacement costs provided for building type.

EQUIPMENT REPLACEMENT LABOUR COSTS (1989) *

BUILDING TYPE		A	B	C
ALL GAS	SPACE HEATING	$40,020	$156,900	$330,660
	CORRIDOR F/A	$2,340	$9,150	$17,820
	DHW HEATING	$2,460	$10,500	$21,120
ALL ELECT	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$5,040	$18,600	$38,280
	DHW HEATING	$6,420	$22,500	$48,180
HYBRID 1	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$4,200	$16,950	$34,980
	DHW HEATING	$2,460	$10,500	$21,120
HYBRID 2	SPACE HEATING	$13,290	$47,100	$99,000
	CORRIDOR F/A	$5,040	$18,600	$38,280
	DHW HEATING	$3,930	$17,400	$35,970

------> Space heating, corridor f/a and domestic hot water system equipment labour costs provided for building type.

ANNUAL ELECTRICITY AND GAS USE SUMMARY **

BUILDING TYPE		A	B	C
ALL GAS	ELEC KWH	138,655	766,379	1,690,636
	GAS EKWH	252,585	1,142,669	2,620,665
	EKWH/SQFT/YR	36.3	35.4	36.4
ALL ELECT	ELEC KWH	277,600	1,395,300	3,119,400
	GAS EKWH	0	0	0
	EKWH/SQFT/YR	25.8	25.9	26.3
HYBRID 1	ELEC KWH	221,411	1,133,327	2,544,030
	GAS EKWH	77,366	363,480	797,826
	EKWH/SQFT/YR	27.7	27.8	28.2
HYBRID 2	ELEC KWH	256,447	1,308,350	2,928,388
	GAS EKWH	26,083	107,120	235,352
	EKWH/SQFT/YR	26.2	26.3	26.7

------> Electricity and gas use provided for building type and city.

------> Average energy use provided for building type.

ANNUAL ELECTRICITY AND GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	GAS	$4,500	$19,500	$43,300
ALL ELECT	ELECT	$6,850	$31,300	$70,450
	GAS	$0	$0	$0
HYBRID 1	ELECT	$4,050	$18,850	$43,150
	GAS	$1,450	$6,350	$13,650
HYBRID 2	ELECT	$6,050	$28,650	$64,650
	GAS	$450	$1,900	$4,000

------> Electricity and gas costs provided for building type.

ANNUAL ELECTRICITY AND DE-REG GAS COSTS ***

BUILDING TYPE		A	B	C
ALL GAS	ELECT	$0	$0	$0
	DE-REG GAS	$4,185	$18,135	$40,269
ALL ELECT	ELECT	$6,850	$31,300	$70,450
	DE-REG GAS	$0	$0	$0
HYBRID 1	ELECT	$4,050	$18,850	$43,150
	DE-REG GAS	$1,349	$5,906	$12,695
HYBRID 2	ELECT	$6,050	$28,650	$64,650
	DE-REG GAS	$419	$1,767	$3,720

------> Electricity and de-reg gas costs provided for building type.

ANNUAL MAINTENANCE COSTS *

BUILDING TYPE		A	B	C
ALL GAS	MATERIAL	$226	$457	$857
	LABOUR	$294	$622	$865
ALL ELECT	MATERIAL	$183	$274	$365
	LABOUR	$165	$248	$330
HYBRID 1	MATERIAL	$163	$244	$325
	LABOUR	$145	$218	$290
HYBRID 2	MATERIAL	$163	$244	$325
	LABOUR	$145	$218	$290

------> Material and labour maintenance costs provided for building type.

LIFE CYCLE COSTS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$225,000	$877,151	$1,850,989
	PER SUITE	$11,250	$8,772	$8,414
	PER SQFT	$20.87	$16.27	$15.61
ALL ELECT	TOTAL	$279,991	$1,130,361	$2,470,749
	PER SUITE	$14,000	$11,304	$11,231
	PER SQFT	$25.97	$20.97	$20.84
HYBRID 1	TOTAL	$217,169	$887,941	$1,933,319
	PER SUITE	$10,858	$8,879	$8,788
	PER SQFT	$20.15	$16.47	$16.30
HYBRID 2	TOTAL	$253,391	$1,062,331	$2,318,980
	PER SUITE	$12,670	$10,623	$10,541
	PER SQFT	$23.51	$19.71	$19.56

------> Life cycle costs.
------> Average life cycle costs per suite.
------> Average life cycle costs per sqft.

LIFE CYCLE COSTS WITH DE-REG GAS ****

BUILDING TYPE		A	B	C
ALL GAS	TOTAL	$219,729	$854,308	$1,800,267
	PER SUITE	$10,986	$8,543	$8,183
	PER SQFT	$20.38	$15.85	$15.18
ALL ELECT	TOTAL	$279,991	$1,130,361	$2,470,749
	PER SUITE	$14,000	$11,304	$11,231
	PER SQFT	$25.97	$20.97	$20.84
HYBRID 1	TOTAL	$215,471	$880,502	$1,917,330
	PER SUITE	$10,774	$8,805	$8,715
	PER SQFT	$19.99	$16.34	$16.17
HYBRID 2	TOTAL	$252,864	$1,060,105	$2,314,294
	PER SUITE	$12,643	$10,601	$10,520
	PER SQFT	$23.46	$19.67	$19.52

------> Life cycle costs with de-reg gas.
------> Average life cycle costs per suite.
------> Average life cycle costs per sqft.

NOTES : * EQUIPMENT WHICH IS NOT COMMON TO BOTH GAS & ELECTRIC SPACE, CORRIDOR FRESH AIR & DHW HEATING SYSTEMS.

** TOTAL ENERGY USED FOR SPACE, CORRIDOR FRESH AIR AND DHW HEATING, COOLING, FANS & PUMPS, ELECTRICAL EQUIPMENT AND LIGHTING. SQ FT USED IS TOTAL BUILDING AREA.

*** ENERGY COSTS FOR SPACE, CORRIDOR FRESH AIR & DHW HEATING ONLY.

**** SQ FT USED IS TOTAL BUILDING AREA.

LCC FOR SENIORS/SINGLES BLDGS

IN THUNDERBAY
IN THUNDERBAY WITH DE-REG GAS

GAS

ID	BLDG TYPE	ID	CITY	EQPT INDEX	LABOUR INDEX
1	FAMILY	1	NORTH YORK	100%	100%
2	SENIORS/SINGLES	2	OTTAWA	103%	115%
		3	KINGSTON	103%	115%
A	PWF	4	SUDBURY	105%	113%
		5	THUNDERBAY	105%	118%
0.9818	36.0420	6	HAMILTON	100%	112%
0.9818	36.0420	7	LONDON	100%	104%
0.9636	23.6290	8	WINDSOR	100%	108%
0.9455	16.7345	9	TORONTO	100%	100%

Graphs

Graphs for life cycle costs versus number of suites (ie. building size) can be displayed using named graphs LCC - REG GAS and LCC - DEREG

Replacement Cycle A Factors

Equipment			Labour		
A	B	C	A	B	C
0.58	0.58	0.58	0.58	0.58	0.58
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69
0.69	0.69	0.69	0.69	0.69	0.69

PW OF WHOLE REPLACEMENTS - EQPT

AARM	ABRM	ACRM
$15,236	$59,340	$124,712
$5,207	$20,324	$41,341
$2,885	$12,315	$25,028
$12,502	$44,098	$92,888
$6,967	$24,747	$51,604
$6,497	$22,870	$48,766
$12,502	$44,098	$92,888
$5,981	$23,808	$48,766
$2,885	$12,315	$25,028
$11,259	$39,641	$83,599
$6,967	$24,747	$51,604
$3,495	$15,129	$31,221

PW OF WHOLE REPLACEMENTS - LABOUR

AARL	ABRL	ACRL
$23,079	$90,481	$190,684
$2,744	$10,731	$20,900
$2,885	$12,315	$24,770
$15,587	$55,240	$116,110
$5,911	$21,815	$44,896
$7,530	$26,389	$56,507
$15,587	$55,240	$116,110
$4,926	$19,879	$41,025
$2,885	$12,315	$24,770
$15,587	$55,240	$116,110
$5,911	$21,815	$44,896
$4,609	$20,407	$42,186